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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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NOTES AND COMMENTS.

A French Works' Educational Scheme.

An interesting system of technical and quasi-technical instruction has been developed by the Compagnie des Forges de Châtillon, Commentry et Neuves Maisons at the St. Jacques Works at Montluçon, and has recently been described in Revue de Métallurgie by M. Bostsarron. The work is divided up into two sections, the one catering for the pre-apprenticeship period, that is for boys whose ages range from 12 to 15, the other the apprenticeship proper, the age range being from 14 to 18.

The organisation includes a pre-apprenticeship workshop-school, which is quite separate from the works, daily apprenticeship courses in the works, an education society and Boy Scout and athletic associations. In the organisation of the school much attention has been given to the physical development of the boys, by the provision of playing fields, covered playgrounds, a gymnasium, baths and individual gardens.

The equipment of the workshop, which is 24 by 3 metres, comprises two blacksmiths' hearths and 30 benches, 17 being joiners', 12 fitters', and one a tinsmith's bench. Additional to these, tables for working with pasteboard and iron wire and for moulding are provided. The only machine tools installed up to now are a lathe and a drilling machine, both being electrically driven. Around the walls of the workshop, cupboards with expanded metal doors are fixed—one for each scholar.

The class room, which accommodates 60 scholars, is furnished with tables and chairs.

A kitchen with three stoves is utilised by the scholars staying over the lunch hour for the purpose of warming up or even the complete preparation of their meal. It further forms part of the organisation of the Boy Scout Association. The duration of the course is largely determined by the needs of the works. We give the accompanying details as the scheme appears to us to combine in a very admirable manner both the mental and physical requirements of youths destined to become the backbone of the works attached to the school.

No conditions other than the age requirements are laid down. All materials are supplied by the works, and scholars may or may not be the sons of the workpeople. The scholars are free to leave whenever they like and can seek employment in any sphere, whether it can be considered as competitive or not. The scholars are not selected on the principle of their ability to pass examinations, the idea of the governors being rather to emphasise their moral education.

Though the school was only opened in 1918, it already has produced excellent results, inasmuch as the type of lad now being apprenticed in the works is superior, morally and intellectually.

The staff consists of one general supervisor, who is responsible for the conduct of the institution, assisted by three foremen specially selected from the works staff, a gymnastic master and a part-time school teacher. The working day is divided into two sessions—the morning half being from 8 to 11 and the afternoon 1 to 6. An analysis of the time table shows that every week some 23 hours are spent in the workshop, six and a half in gardening and general out-of-doors work and six in physical culture. Games, free and supervised, take up six and general education some twelve hours per week.

We notice with regret that the school has failed somewhat from the foundryman's point of view, as ninety-five per cent. of the scholars decided upon following the trade of a mechanic or fitter, showing a marked preference for "cold work." It should be pointed out, however, that probably home influence had much to do with this state of affairs.

The department managers report that the scheme of pre-apprenticeship is to be commended on the following grounds:—(1) The boys are found to be more prompt and agile; (2) they assimilate and carry out much more quickly the technical orders given to them and with a greater assurance; (3) they are more polite, take a greater pride in their clothes and are generally cleaner; (4) increased output, as after a few months they are six months ahead of boys not having passed through the school.

The actual apprenticeship courses have been organised since 1905, the special features being laboratory-workshops, a daily lecture of 2 hours' duration and evening classes. At the end of 3 years the apprentices are examined and if proficient, receive a certificate showing that they are skilled men. The introduction of the eight-hour day has caused much difficulty with the apprenticeship courses, as in many departments of French works the shift is carried through without a break, which renders the attendance at the end-of-day classes more fatiguing.

The above remarks are given with the hope that they may assist some of the organisations who are now tackling the question of apprenticeship, which is becoming increasingly difficult for the foundry manager.

XUM

The Teams Iron Works.

As constituted to-day the Teams Iron Works of the Redheugh Iron and Steel Company, Limited, Newcastle-on-Tyne, are one of the best examples in the North of an old works brought fully into line with modern requirements.

The Redheugh Iron and Steel Company has been in existence for upwards of 50 years, having been originally engaged in rolling iron plates and sheets, and latterly in rolling mild steel. In 1918 the business was converted into a limited company, since when the developments referred to have taken place and the scope of the works very considerably extended.

The scheme included modernising the rolling mills and improving the facilities for handling the raw materials and finished products; also the building and equipping of a plating shop for utilising such portions of the output of the mills as could not be profitably disposed of in other directions. This has proved a very valuable asset, a considerable trade having already been built up in the manufacture of welded sheet iron and light plate constructions, more particularly for the electrical and shipbuilding industries. Machine shops were erected for carrying out repairs to the mills, as also to deal with the machining necessary for other departments of the works. These machine shops, however, proving to be above the normal requirements of the works, led to a decision to undertake general engineer-

FIG. 1.—PART VIEW OF FOUNDRY; TEAMS IRON WORKS.

ing work and repairs for collieries, etc., with a special provision for gear-cutting, etc. It was then found extremely difficult to obtain an adequate supply of castings, and in order to meet this drawback a foundry was laid down capable of producing castings up to 10 tons in weight.

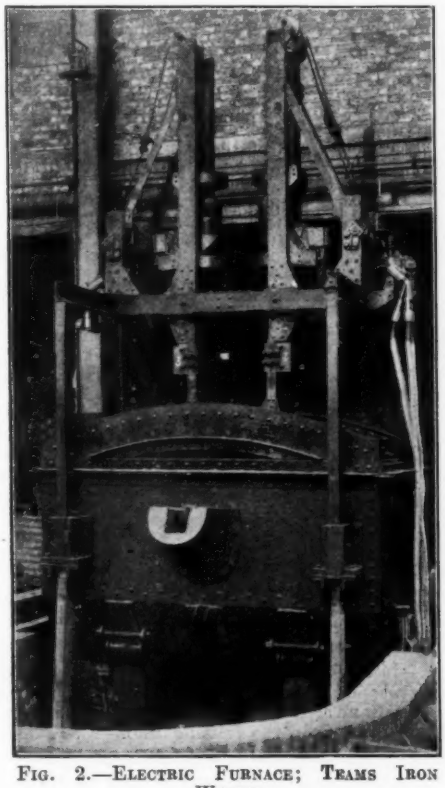

FIG. 2.—ELECTRIC FURNACE; TEAMS IRON WORKS.

Obviously in a works of this nature considerable quantities of steel scrap are produced, and in order to turn this to the most profitable account, as also to meet the demand for special steels, an electric furnace was put down, so that the foundry as in operation to-day is probably one of the best equipped on the North-East Coast.

The Works are conveniently situated at Teams, about two miles from Newcastle-on-Tyne, and are served by a siding from the Tanfield branch of the North-Eastern Railway. Very extensive yardage is available, and the whole is laid with a network of narrow-gauge rails, similar service being provided for the mills, foundry, and each of the shops. A Jeffrey electric locomotive (5 tons) does the Works' haulage, but in addition to this the tracks are traversed by three Royce 7-cwt. electric jib cranes.

The stocking ground is spanned by a 60-ft. gantry with a length of runway of 400 ft., and is served by a 3-ton Herbert-Morris crane, which carries an Allen West lifting magnet. At the moment there is installed a set of motor-driven breaking down shears, equal to cutting slabs up to 18-in. × 2-in., but a second set will shortly be laid down equal to cutting blooms 2-in. × 4-in.

Dealing first with the rolling-mill plant, the No. 2 mill comprises a stand of 26-in. hard and a stand of 26-in. soft rolls, whilst provision has been made for a stand of chequer rolls. The mill housings, of cast steel, have V-type bedplates, 8-ft. centres, on cast-steel rails. The soft rolls are provided with hydraulic lifting tables, whilst between the stands of rolls is a transfer table driven by a 22-h.p. motor. The screwdown gear is also driven by a 22-h.p. motor. The mill is driven by a 350-h.p. Westinghouse motor geared 4 to 1 through double-helical reduction gear to the intermediate shaft, upon which last is mounted a 30-ton flywheel 12 ft. in dia. The final reduction, giving a roll speed of 42 r.p.m., is through double-helical wheels 26 in. on the face. The whole of the gearing is enclosed in oil-tight cases and forced-lubricated by gravity; sight-feed lubricators are also provided. It was found that the existing Siemens furnaces which served the mill were slightly under size, and to meet the full mill demand a Stein & Atkinson continuous furnace has been laid down alongside, the handling of the coal and the operation of the producer for this furnace being entirely automatic. In the No. 2 mill plates up to 5-ft. in width and of a maximum weight of 1,200 lbs. are rolled.

The No. 1 mill, comprising a stand each of soft and grain rolls 24 in. in dia., is motor-driven through ropes and gear-wheels, and is able to do similar work to No. 2 mill.

Passing now to the engineering side of the Works, the foundry forms a right-angle to the stocking ground. The material for the cupolas is conveyed in trucks over the lines of track and tipped direct into the hoist, which, driven by a 3-h.p. motor, handles a load of 10 cwts, and is automatic in action. The charging platform is common to the two cupolas, which have a capacity of 6 tons and 3 tons per hour respectively; these cupolas were supplied by the Construction Engineering Company, Limited, and are blown by motor-driven Keith-Blackman fans. The foundry building is 350 ft. long and consists of a main bay 60 ft. wide, 35 ft. high to the eaves, with an Anderson (Belfast) roof; there is excellent roof

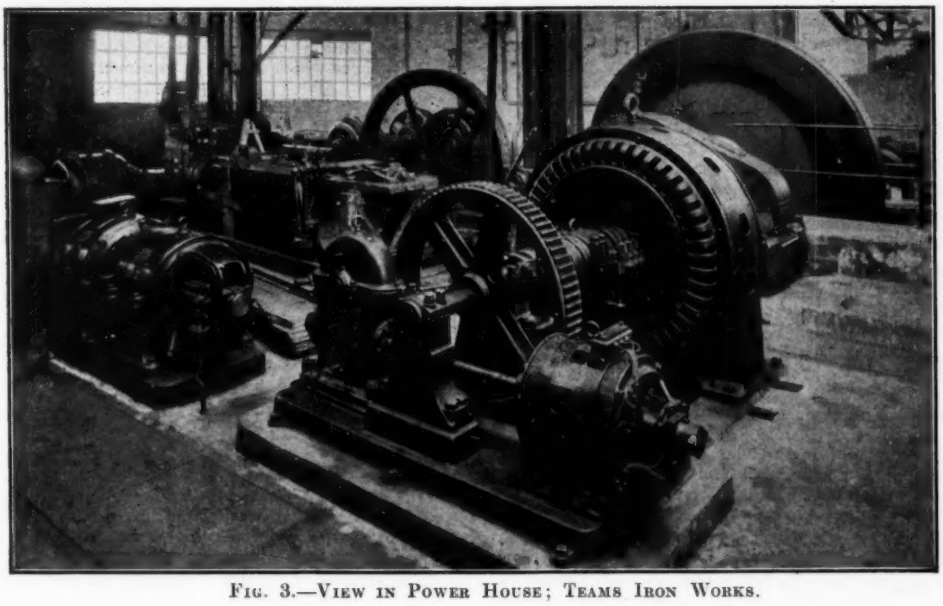

FIG. 3.—VIEW IN POWER HOUSE; TEAMS IRON WORKS.

lighting, and in addition 12 ft. of glass on either side. The floor is served by two Herbert-Morris 10-ton 3-motor cranes.

Two moulding machines, by Macdonald & Son, Limited, Glasgow, are installed with tables 3 ft. 6 in. square and 4 ft. 6 in. square respectively; naturally, however, in a foundry of this nature the bulk of the work has to be hand moulded.

On the west of the main bay is a lean-to 30 ft. wide which serves to house the cupolas; beyond the latter are two drying stoves 20 ft. × 17 ft. and 15 ft. × 17 ft. respectively; these are coke-fired, and in addition there is a Priest core-drying stove fired on the Priest system of saturated blast, while beyond this last is the sand-mixing and grinding shop, with the usual equipment. In the base of an annexe 30 ft. wide on the east side of the main bay are the storage bins for the scrap and additions for the electric furnace, which last is of Stobie manufacture, and of 3 tons melting capacity. The usual electrical equipment is provided, and there is a coke-fired stove for heating the ladles. The floor of the main bay is common to both the iron and steel castings. Above the annexe is the pattern shop, with a pattern store adjoining. The machines include band and circular saws, surfacing and planing machines, lathes, drilling and sand-papering machines, etc., the whole being driven from line shafting from an elevated motor. Also adjoining, is a particularly roomy and well-equipped laboratory, where all raw materials and samples from casts are subject to a rigid analysis; in the laboratory are also installed the recording pyrometers, so that the temperatures are always under the direct supervision of the chemist. The foundry manager's and time-keeper's offices form part of the same building.

The fettling shop, which adjoins the foundry, is in process of completion. It occupies a building 120 ft. by 60 ft., with provision for extension, and is served by a 10-ton crane. A Tilghman's sand-blast plant is installed, and compressed-air mains are laid completely round the shop. At one end of the shop is a Priest bogie annealing furnace, fired on the saturated air-blast system, with chamber accommodation for a bogie 17 ft. × 6 ft.

The main machine shop occupies a building 250 ft. in length, the bay for the heavy machines 30 ft. wide, and that for the light machines 20 ft. wide, being each served with a Vaughan 5½-ton crane. Amongst the heavy machines installed, practically all of which are driven by independent motors, mention may be made of a Spencer planer 20 ft. × 6 ft.; a radial drilling machine with a 6-ft. arm, by the Pond Machine Tool Co.; a Greenwood & Batley 18-in slotter; a Kendall & Gent vertical miller; shaping machines by Thos. Ward, Sheffield; a Dean, Smith & Grace heavy side planer, and a 36-in. slotting machine by Armstrong, Whitworth and Company.

The machines installed in the light machine shop comprise lathes, shaping machines, drilling machines, a Denham's milling machine and by the same makers a 6-in. slotting machine with a canting table, Brown & Sharpe crank-shaft grinder, a Heald Machine Co. cylinder grinder, an Alfd. Herbert milling machine, a number of Cincinatti grinders, a Sunderland No. 6A gear planer, a Gleason bevel-gear generator, etc.

The erecting shop occupies a building 150 ft. in length covered by two bays of 30 ft. and 20 ft. respectively, and a lean-to for benches, etc., 17 ft. wide; the bays are each served by a 10-ton 3-motor crane.

The plating shop adjoins the mill building; it is 375 ft. in length × 60 ft., covered with an all-glass roof, and served by Royce cranes. The machine tools comprise Bradley & Craven 6-ft. shearing machines, and 6-ft. flanging presses, while there is a very complete installation of both Oxy-Acetylene and Quasi-Arc welding plants. At the time of our representative's visit an almost endless variety of work was going through the shop, including transformer tanks, explosion-proof high-tension oil-switch tanks, ships' ventilators, pipe lines, and a vacuum tank. The latter measured 15 ft. in dia. × 18 ft. 6 in. long: it was electrically-welded throughout, and, with no internal stays, had passed the necessary test of 100 lbs. per sq. in.

Light plating is done in a separate shop, in which a Marryat & Place spot welder is in service.

The power house, which serves to house the mill drive for the No. 2 mill, contains an electrically-driven air compressor; an 80-kw. motor-generator, 240 volts D.C., for the supply of energy to the cranes and also for lighting; a 110-volt motor-generator of 80-kw., for the welding plant, and a duplex hydraulic pump, which, motor-driven through gearing, works at a pressure of 750 lbs. per sq. in. for service at the mills and in the plating shop. Power is taken from the Newcastle Electricity Supply Co., and the whole of the switchgear is of Reyrolle manufacture.

Cleaning Brass Scrap.

American patent No. 1,375,930 has been granted to Oliver C. Ralston for a process of treating brass scrap, based upon the principle that aluminum, iron and other metals which are electro-positive to copper can be removed from brass scrap and related copper-bearing alloys by treating these materials with an aqueous solution of cupric chloride or with a weak hydrochloric acid solution into which chlorine gas is introduced. With a brass scrap containing 35 per cent. of zinc and 0.2 per cent. of iron, the contents of these metals were reduced to 10 per cent. and 0.05 per cent. respectively, and the total loss of the charge did not exceed 48 per cent.

Queries Answered.

Reclaiming Burnt Sands.

P1.—Is it possible to recover or reclaim burnt foundry sand, apart from the method of mixing with new sand? By this we mean such sand that is usually found in the fettling shop.—C. T. C.

P2.—The plasticity of sand is due to its clay content. Pure clay can be represented by the formulæ Al_2O_3, 2 SiO_2, 3 H_2O, which means that one part of alumina is chemically combined with two parts of silica and three of water. This combined water must not be confused with absorbed or hygroscopic water, the difference being that the latter can be augmented or reduced at will, but the former, the combined water, once it has been driven off by intense heat, cannot be replaced by any known means. Therefore, the only way of using up burnt sand in moulding sands is to employ it for diluting mixtures which are too "strong"—that is, those which contain too much clay.

RECLAIMING FOUNDRY SANDS.—A joint research on this subject is to be carried out by the American Bureau of Mines and the American Foundrymen's Association.

BULGARIAN RAILWAY REQUIREMENTS.—The Bulgarian State Railways have invited tenders for the supply of machine tools, including lathes, planes, thread cutters, milling machines, etc., etc. Tenders must be presented in Sofia by August 6. Copy of specification and condition of tender may be consulted by United Kingdom manufacturers and exporters on application to Room 50, Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1.

PIG-IRON ANALYSES.—A CORRECTION.—The question of the variation in the composition having been raised in our correspondence columns, we consider that it is advisable to point out that in his Paper on "Some Experiences of Cupola Practice," read before the Manchester Branch of the Institution of British Foundrymen, Mr. Pell's approximate analysis figures for Thorncliffe No. 3 and Gartsherrie No. 3 should read 0.026 and 0.022 per cent. of sulphur respectively. Unfortunately, his amended figures reached this office too late for inclusion in the report of the Paper. Obviously, the above correction modifies the average sulphur figures in the mixings.

A Model Pattern Stores.*

By GILBERT L. LACHER.

To a large foundry which uses many thousands of patterns, the problem of providing suitable storage facilities is important. Not only must heed be given to the principles of convenience and system in storing patterns, but also to the protection of the patterns from destruction by fire. Ease in conveying patterns from storage to foundry is also a consideration, while the necessity of keeping an accurate record for the location of patterns, to prevent delay and confusion in finding them when needed, is especially pressing in a plant where the number stored is large.

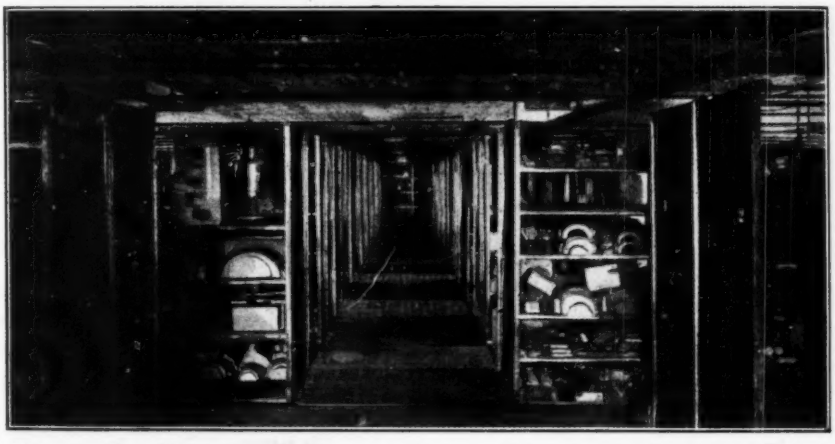

FIG. 1.—THE MEZZANINE FLOOR IN A PATTERN STORES MADE OF REMOVABLE PLATES.

All the desirable features mentioned are embodied in the new pattern storage of the Whiting Corporation, Harvey, Ill. It is a four-storey and basement building of fireproof construction, 56 × 96 ft. Floors and columns are of reinforced concrete, the interior walls of hollow tile and the exterior of brick. The roof of the structure, also of reinforced concrete, is covered with built-up prepared paper roofing with a coating of tar and gravel. When the transfer of patterns to the new storage building has been completed, fully 18,000 live and recently used patterns will be housed in it, while 4,000 or 5,000 obsolete patterns will be kept in old storage rooms.

Heavy pattern storage is situated in the basement, while the other storage floors are the third and fourth stories, two floors to a storey. There are 44 steel storage racks on each floor, furnished by the Lyon Metallic Company, Aurora, Ill. Each rack is divided into four to six sections, and each section has four to five adjustable shelves. The number of shelves to a section varies according to the size of the patterns to be stored.

Mezzanine floors were provided in both stories by placing subway grating, made by the Irving Iron Works, Long Island City, N.Y., on 2 in. × 2 in. angles flanged out from the racks, to which they are bolted at a height of 7½ ft. from the floor, shown in Fig. 1. The grating is fastened to the angle on which it rests by a notched fixture which fits on to the angle. As the entire net height of each storey is 14 ft., the height from mezzanine grating to the ceiling is 6½ ft. The racks and mezzanine gratings can easily be taken apart and removed.

Each storage floor has one main central aisle and two end cross aisles, served by ceiling lights, and two side aisles equipped with drop cords. The drop lights, when not in use, are hung by hook on wires strung along the top of the pattern racks. The bottom and mezzanine floors have separate lighting switchboards, although most of the wiring is carried on the ceiling. Each storage floor has eight separate lighting divisions, so that a minimum of lights may be used when patterns are brought to the floor for storage, or are to be removed for use. The switch panel, at the end of each floor, is adjacent to the stairway and elevator shaft. The storage stories are provided with sufficient windows to be used for shop purposes, if desired. The general arrangement of the department is shown in Fig. 2.

To keep an accurate record of the position of the patterns, a card system furnished by the Acme Card System Company, Chicago, has been provided. The cards contain spaces for all necessary data, such as the drawing number, the material, the date the pattern was made, its size and weight, a record of alterations, the dates on which the pattern went to the foundry and was returned, or was shipped to and returned from an outside foundry on contract work. As the same core box is sometimes used for a number of patterns, or different core boxes are used with one pattern, their location is also recorded on the card.

Perforations in the top of cards permit clips to be inserted to hold them on racks, of which the Whiting Corporation has two, each with a capacity of 20,000 cards. When hung on the rack the cards show only the lips projecting from the bottom, and on these lips the most important data are recorded—the number of the pattern and its location in the pattern storage.

The position of patterns are indicated by a unique system. Each storage floor has been given a letter—A, B, C, etc. Likewise each rack is given a number, each rack section a letter and each shelf a number. Hence, if a pattern should have a location designation of A-2-B-4, it would mean that it could be found on floor A, in rack No. 2, in rack section B, on shelf No. 4. The cards also have space at the top for the pattern number and location, so that, if desired, the cards may be kept in an ordinary vertical box file.

The same building which contains the pattern storage also contains the pattern and flask shops. These are located on the first and second floors, which are provided with continuous sash and are hence exceptionally well lighted. The first floor contains the pattern lay-out department and carpenters' shop, a flask shop and a pattern timber storage. The portion of the floor carrying the timber has been specially reinforced to carry 500 lb. per sq. ft., as compared with 150 lb. per sq. ft.

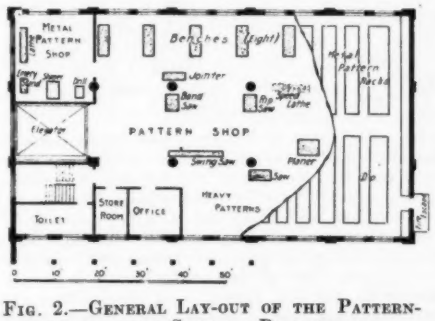

FIG. 2.—GENERAL LAY-OUT OF THE PATTERN-MAKING AND STORING DEPARTMENT.

* Extracted from the "Iron Age."

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for the remainder. The flask shop is equipped with a motor-driven swing saw. Completed flasks are carried by overhead monorail out of the building and lowered to cars on an industrial track, by which they are conveyed to the foundry or to the storage yard.

On the second floor is the pattern shop. Along the north windows are nine pattern benches, with metal frames and heavy wooden tops. Each bench has electrical connections for lights and small motors. There is sufficient space next the wall to permit easy passage around the benches. Electrically-heated glue-pots are situated at convenient points between the wall and the benches. Here also is a numbering machine for pressing out the numbers which are attached to the patterns. The position of the woodworking machines is indicated in Fig. 2.

The south side of the shop is reserved for heavy pattern work. Here also is placed a repair bench for minor repairs and alterations. It frequently happens that the same pattern is used for different jobs, and that minor changes, such as the attaching or removal of hubs, must be made. There is also a numbering machine in this department, to stamp out numbers for altered patterns. In the north-west corner of the floor is the metal pattern-making shop, the equipment of which includes an 18-in. engine lathe, a sensitive drill, and an emery stand. A shaper will also be installed.

Compressed air is available at convenient points on the second floor. As in the carpenters' shop, all sawdust from the woodworking machines is drawn off by a fan. On this floor also are located the main control panel for the incoming circuit, by means of which all current may be shut off, or one or more floors may be cut off; the main power panel for the alternating current, which is distributed throughout the main floors, and also operates the motor for the exhaust fan in the basement, and a panel for direct current, which has been provided for machine operation, when desired.

A Double Dimension Sawing Machine.

The machine illustrated in Fig. 1 is a 16-in. universal double dimension saw, manufactured by Messrs. Wadkin & Company, of Leicester. It is a useful tool and covers a wide sphere of application, being suitable for ripping, cross cutting, levelling, tongueing and grooving, mitreing, sticking small mouldings, cutting compound angles, roughing out core-boxes, and a variety of work found in practically every pattern-shop.

The machine may be driven by a motor fixed on the floor immediately at side of the main frame and driving on to the saw spindles by belt, or by ordinary belt drive from a line shaft.

An automatic idler bracket fixed inside the main frame and carrying two idler pulleys running on ball bearings is provided which gives the correct tension to the driving belt quite irrespective of the position of the saws in relation to the table top.

The main frame is a single casting, heavily ribbed internally and provided with a large base which eliminates vibration. Inside the body is a partition, cast solid with the main frame, dividing the inside into two parts, one for the saws and one for the pulleys, bearings and belts. This partition is also ribbed and has a machined circular opening 21-in. diameter forming a solid bearing for the turned disc carrying the saw-spindle bearings. This construction obviates the use of any outside bearing to the saw frame, and allows free access when changing saws. Ample protection is afforded the operator by the cast-iron door at the front of the machine, which entirely covers the saws. The heavily ribbed cast-iron table is divided into two parts, the right hand half being stationary and the left hand half sliding to and fro on ball bearings confined in angular raceways carried on a frame supported on extensions of the fixed table. This arrangement practically eliminates friction in moving it past the saw.

As shown in the illustration, the entire table tilts by worm and worm-wheel gearing through various angles up to 45 degs. with the horizontal; the graduated index which is provided shows the angle at a glance. Extra long lift-plates running against machined ways keep the sliding table in position. This sliding table has a movement by screw and hand wheel in a direction away from the main table, thus forming an adjustable width of gap. Means are provided for attaching a wooden gap plate through which grooving saws or cutters can project. The frame carrying the two saw spindles is a strong casting, and has a turned disc at one end and a journal bearing at the other, to which is attached a cut worm-wheel for revolving the saw frame, which can be operated whilst the machine is stationary or in motion; suitable means are provided for eliminating end play. The spindle bearing next to the saw in each case contains two ball bearings, whilst the other contains one ball bearing. All bearings are dust-proof, packed with grease, and fitted with screw lubricators. The ripping fence has a front fence-plate which cants from the vertical to 45 degs. It is arranged to swivel 30 degs. either way, and has a quick motion across the table by hand and a fine adjustment by screw; it can be used on the sliding table if desired.

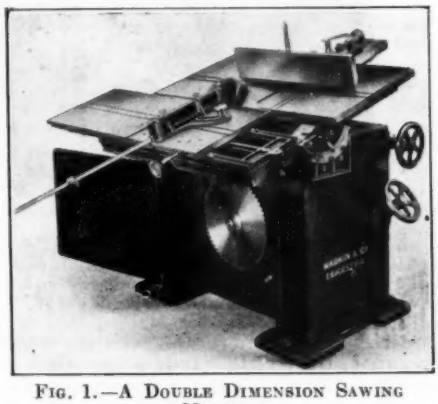


FIG. 1.—A DOUBLE DIMENSION SAWING MACHINE.

The cutting-off gauge is arranged to swivel right and left hand, the angles being suitably marked on the sliding table surface; a spring plunger pin gives the standard angles without referring to the index on the table. An adapted sliding stop-rod fitted with two clamps is provided. Two universal mitre gauges are mounted, one on each side of the saw; they operate on steel bars sliding in machined ways in the table surface, each gauge being indexed and arranged to swivel either right or left hand. Adjustable stop-rods, clamps, and stops are provided with each fence.

We give below a few sizes which gives an idea of the capacity and practical utility of the machine:—Size of complete table-top, 3 ft. 8 in. long by 3 ft. 2 in. wide, the sliding section is 3 ft. 8 in. long by 1 ft. 10 in. wide, and the extension to the fixed table, 13 in. The throat between fixed table and sliding table opens 2¾ in. to allow a wobbling saw or cutterlock to be used. The pulleys on the saw spindle are 4½ in. dia. by 4½ in. face, the speed being 2,500 r.p.m. The machine can take one saw 22 in. dia. and rips 24 in. wide and cuts off 36 in. long, using the stops on the cross-cut fences. The maximum depth of the cut using 16 in. dia. saws is 4 in.

THE Rand Water Board, South Africa, is inviting tenders for the supply and delivery of the following quantities of pipes, valves and specials required for pipe lines in connection with the Vaal River Scheme :—Contract No. 204 : 70,100 ft., internal diameter, 22 in. : 70,400 ft., internal diameter, 24 in. Contract No. 206 : 29,300 ft., internal diameter, 18 in. ; 29,350 ft., internal diameter, 21 in. ; 30,150 ft., internal diameter, 24 in. Tenders should be addressed to the Secretary, Rand Water Board, Second Floor, Central House, or P.O. Box 1703, Johannesburg, not later than 12 noon on September 6, 1921. Full particulars on application to the Department of Overseas Trade, Room 50a, 35, Old Queen Street, Westminster, S.W 1.

Some Notes on Case Hardening.—Part II.

By Christian Kluytmans.

Case-hardening steels used in automobile manufacture are not very numerous, they may be divided into: (*a*) ordinary carbon steels; (*b*) nickel steels; (*c*) nickel-chrome steels; (*d*) chrome-vanadium steels. The last steel named being not in common use in England, and has not been included in the author's experiments. The steels dealt with have the following composition:—

(*a*) *Carbon Steels.*—(1) C., 0.11; Mn., 0.28; Si., 0.20; S., 0.04; P., 0.042. (2) C., 0.12; Mn., 0.88; Si., 0.17; S., 0.035; P., 0.038.

(*b*) *Nickel steels.*—(3) C., 0.10; Mn., .35; Si., 0.22; S., 0.034; P., 0.034; Ni., 2.97. (4) C., 0.08; Mn., 0.32; Si., 0.17; S , 0.034; P., 0.032; Ni., 5.1; Cr., 0.22.

(*c*) *Nickel chromium steel.*—(5) C., 0.10; Mn., 0.42; Si., 0.21; S., 0.03; P., 0.035; Ni., 3.42; Cr., 0.87; Va., 0.12.

Carbonising.—The object of the carbonising operation is to obtain an outer portion with a higher carbon content, which, after treatment, will be very much harder than the core, which will have to remain soft and ductile.

As a rule, it is believed that carbonising done at the highest temperature permissible, gives the quickest penetration of carbon. This is true if the results regarding the excess of cementite produced by a fast penetration were not liable to give a very brittle case and an abrupt demarcation between case and core.

It is a known fact that after the carbonising operation the steel is in an overheated condition, *i.e.*, with an austenitic structure. If quenched directly from the carbonising temperature this structure will be fixed by sudden cooling, and the result will be a very low impact value. The part treated will be very brittle, therefore it is understood that any case-hardening steel cannot be quenched from the carbonising temperature, but must be allowed to cool in the boxes, free from contact with air, so as to avoid any decarburisation of the skin. The core will soon have its original carbon content, and the same critical point as before carbonising, while the case will have its carbon content raised up to, say, 0.9 per cent., which considerably lowers its critical point.

There are then two different steels on the same piece, which need to be treated differently in order to obtain maximum mechanical properties.

Quenching or Hardening Temperature.—As a rule, two quenchings are sufficient to refine core and case, but sometimes a third is required.

First Quenching.—The refining of the core is always carried out 50 per cent. above its higher transformation point, either in water or oil, according to the analysis of the steel. The overheated nature of the case (from carbonising) is not refined by this operation.

Second Quenching.—The case is refined either in water or oil at not higher than 50 deg. C above its critical point.

Third Reheating.—This is for the purpose of relieving internal stresses produced by the two first quenchings, and is followed by cooling in either air or oil.

Obviously to carbonise and quench at the correct temperature it is necessary to know the analysis of steel used and also their transformation points.

The five steels outlined above have the following higher critical points shown in centigrade degrees:—No. 1, 904; No. 2, 840; No. 3, 704; No. 4, 695; No. 5, 720.

In order to prove the above temperatures to be correct, experiments have been carried out. The case-hardening compound used had the following composition:—Volatile matters, 16.5 ash, 7.9; humidity, 7.5; matter soluble in water, 0.5; fixed carbon, 67.6 per cent.

After case-hardening, the cases having a higher carbon content, the higher critical point of this case will be as follows:—No. 1, 690; No. 2, 685; No. 3, 650; No. 4, 600; No. 5, 670.

TABLE VI.—*Showing the heat treatment to which the samples were submitted.*

Treatment No	Carbonising Temperature.	1st Quenching Temperature.	2nd Quenching Temperature.
1	950	960 W.	800 W.
2	900	900 W.	760 W.
3	870	840 O.	750 O.
4	850	760 O.	710 O.
5	850	840 W.	710 W.
6	850	760 W.	710 W.

O = Oil. W = Water.

TABLE VII.—*Giving the character of the fractures of the various specimens.*

Plate No.	Fig.	Case.	Core.
1	1	Granular	Mottled grey.
1	2	Fine grey	Medium sized cystals.
1	3	Finer grey ..	Large crystals.
1	4	Very fine grey ..	Very large crystals.
2	1	Granular	Coarse crystalline.
2	2	Fine grey	Fibrous dark grey.
2	3	Finer grey.. ..	Small crystals.
2	4	Very fine grey ..	Large crystals.
3	1	Granular	Crystalline.
3	2	Granular	Granular.
3	3	Slightly granular	Short fibres.
3	4	Fine grey	Silky fibrous.
4	1	Granular.	Small crystals.
4	2	Granular	Small crystals.
4	3	Granular	Short fibres.
4	4	Fine grey	Silky fibrous.
5	1	Granular	Fine granular.
5	2	Granular	Fine granular.
5	3	Fine grey	Fibrous.
5	4	Fine grey	Silky fibrous.

A series of experiments were carried out on the five steels, five bars, each 1 ft. long, were carbonised at the above temperatures, shown in Table VI., for six hours, plus the time necessary to heat the boxes.

The results obtained are summarised in Tables I. to V., and the fractures and corresponding micrographs are illustrated in Plates I. to V.

TABLE I.—*The Physical Properties of Steel No. 1 (Ordinary Low Carbon Steel).*

Heat Treatment No.	Depth of case in mms.	Scleroscope hardness No.	Brinell hardness No. (core)	Max. stress tons sq. in.	Yield point tons sq. in.	Elongation per cent.	Reduction of area per cent.	Impact ft.-lbs.	Microstructure		
									Case	Intermediate	Core
1	2.0	85	179	35	22	35	35	75	Martensitic (Micro. 11).	Double abrupt demarcations between case and core (micro. 11).	Ferrite, with traces of sorbite Martensite (micro. 11).
2.	1.5	90–93	159	34.8	23	34.8	61.0	28	Martensitic and troostitic (micro. 12).	Single demarcation (micro. 12).	Ferrite, pearlite, and traces of sorbite (micro. 12).
3.	1.25	48–50	153	36.0	28	36.0	56	19	Troostitic and Martensitic (micro. 13).	Penetration of carbon more regular. Demarcation not so abrupt.	Ferrite and pearlite.
4.	1.0	43–45	170	32.0	23	32.0	63	19	Troostite and Martensite (micro. 14).	Penetration of carbon very slow (micro. 14).	Pearlite and ferrite (micro. 14).

XUM

Comparison of Results Obtained.

If Steels Nos. 1 to 5 are compared, taking into consideration each treatment, the following conclusions can be drawn :—

owing to the second quenching being too high. (In order to improve the case of Steel No. 1 the second quenching temperature has been carried out at 760 deg. C.)

TABLE II.—*The Physical Properties of Steel No. 2 (Ordinary Low Carbon Steel).*

Heat Treatment No.	Depth of case in mms.	Scleroscope hardness No.	Brinell hardness No. (core)	Max. stress tons sq. in.	Yield point tons sq. in.	Elongation per cent.	Reduction of area per cent.	Impact ft.-lbs.	Microstructure		
									Case	Intermediate	Core
1.	2.5	88	159	36.0	23.0	35	68.0	45.0	Martensite and troostite (micro. 15).	Abrupt demarcation.	Austenitic.
2.	1.70	90	156	40.0	25.0	28	63.0	80.6	Martensite (micro. 16).	Demarcation less accentuated.	Ferrite, Martensite, and traces of sorbite.
3.	1.75	50	156	36.0	24.2	21	57.0	24.0	Martensite (micro. 17).	—	Ditto.
4.	1.10	60	163	30.9	21.0	31	63.7	30.0	Martensite (micro. 18).	—	Ditto.

TABLE III.—*Physical Properties of Steel No. 3 (3 per Cent. Nickel Steel).*

Heat Treatment No.	Depth of case in mms.	Scleroscope hardness No.	Brinell hardness No. (case)	Max. stress tons sq. in.	Yield point tons sq. in.	Elongation per cent.	Reduction of area per cent.	Impact ft.-lbs.	Microstructure		
									Case	Intermediate	Core
1.	2.25	76	318	66	46	19	40	16	Austenitic (micro. 19).	Abrupt demarcation due to excessively high quenching temperature (micro. 19).	Austenitic (micro. 19).
2.	1.65	66	255	65	51	21	42	16	Austenitic (micro. 20).	Ditto (micro. 20).	Ditto (micro. 20).
3.	1.9	73	241	45	31	32	53	58	Martensitic, with traces of Austenite (micro. 21).	Ditto (micro. 21).	Martensitic (micro. 21).
4.	1.7	80–85	217	45	31	32	57	77	Martensitic (micro. 22).	No abrupt demarcation (micro. 22).	Ferrite and Martensite (micro. 22).

TABLE IV.—*The Physical Properties of Steel No. 4 (5 per cent. Nickel Steel).*

Heat Treatment No.	Depth of case in mms.	Scleroscope hardness No.	Brinell hardness No. (core)	Max. stress tons sq. in.	Yield point tons sq. in.	Elongation per cent.	Reduction of area per cent.	Impact ft.-lbs.	Microstructure		
									Case	Intermediate	Core
1.	2.25	75	321	83	66	16.0	—	13.0	Austenitic (micro. 23)	Abrupt demarcation (micro. 23)	Austenitic (micro. 23)
2.	1.6	65–70	364	70	55	17.0	—	13.9	Austenitic (micro. 24)	Abrupt demarcation (micro. 24)	Austenitic (micro. 24)
3.	1.9	75–80	286	66	50	23.0	—	28.0	Austenitic (micro. 25)	Faint demarcation (micro. 25)	Austenitic (micro. 25)
4.	1.7	80–85	228	50	38	36.0	—	75.0	Martensitic (micro. 26)	No demarcation (micro. 26)	Ferrite and martensite (micro. 28)

TABLE V.—*Physical Properties of Steel No. 5 (Nickel Chrome Steel).*

Heat Treatment No.	Depth of case in mms.	Scleroscope hardness No.	Brinell hardness No. (core)	Max. stress tons sq. in.	Yield point tons sq. in.	Elongation per cent.	Reduction of area per cent.	Impact ft.-lbs.	Microstructure		
									Case	Intermediate	Core
1.	2.0	69	418	100.2	62	16.0	55.0	24	Spheroidal cementite embedded in Austenitic matrix (micro. 27)	Abrupt demarcation (micro. 27)	Martensitic (micro. 27)
2.	1.9	75	332	71.0	56	22.0	49.0	34	Ditto. (micro. 28)	Ditto. (micro. 28	Ditto. (micro. 28)
3.	1.8	55	302	63.0	47	23.0	56.0	47	Ditto.	Ditto.	Ditto.
4.	1.5	60	217	42.0	34	23.0	65.0	95	Spheroidal cementite embedded in martensitic structure	Ditto.	Ferrite martensite and sorbite
5.	1.5	88	286	54.0	46	26.0	68.0	81	Ditto. (micro. 29)	Ditto. (micro. 29)	Ditto. (micro. 29)
6.	1.5	92	228	47.0	38	30.0	68.0	84	Ditto. (micro. 30)	Ditto. (micro. 30)	Ditto (mi.cro.30)

Treatment No. 1

The first treatment, that is carbonising at 950, and water quenching 960 and 800 deg., was carried out at too high a temperature.

Case.—All the samples have an overheated case,

Core.—All steels, with the exception of No. 1, have an overheated core, *i.e.*, crystalline. This is due to the first quenching being too high. The second quenching has not destroyed the overheated structure of Steel No. 2, being far below its criti-

cal point. Additionally, the overheating has been doubled in Steels Nos. 3, 4 and 5, the second temperature being far above their critical points.

Depth of Case.—This is fairly constant for the same temperature.

Hardness.—The maximum hardness has not been obtained, owing to the overheated nature of the case. It is to be noted that Steel No. 1, in which the second quenching was carried out at 800 deg., has a scleroscope reading of 85, whilst when quenched at 760 deg. C., the reading is 93.

Brinell.—The hardness, as shown by the Brinell No., is proportional to the analysis of steel and the maximum stress. The mechanical properties are fairly good with Steel No. 1, but have yielded extremely poor, impact values for the other steels.

Microscopic Examination.—This reveals an abrupt demarcation, which is more pronounced in carbon case-hardening steels than in alloy steels, due no doubt to a too rapid penetration of carbon, owing to the high temperatures of carbonising.

The conclusions are that the first treatment is only suitable for Steel No. 1, having the second quenching temperature carried out at 760 deg. C. in water.

Treatment No. 2.

The second treatment, in which carbonising was carried out at 900 and the two water-quenchings at 900 and 760 deg. respectively, resulted in Steel No. 1 having a crystalline core owing to the quenching temperature being below the critical point. Steel No. 2 had a silky fibrous core owing to the first quenching being carried out 50 deg. above its critical point, and Steels Nos. 3, 4 and 5 are overheated, their critical points being far below the second quenching temperatures.

Depth of Case.—This is fairly normal, although in Steel No. 5 the chromium shows a tendency to help the penetration of carbon by having 1.9 mm. depth, against an average of 1.6 mm.

Hardness.—A maximum hardness is reached with the carbon steel, but it is still low with the alloy steels.

Mechanical Properties.—The best tests are shown by Steel No. 2, Steels Nos. 1, 3, and 4 giving very low impact values.

PLATE I.

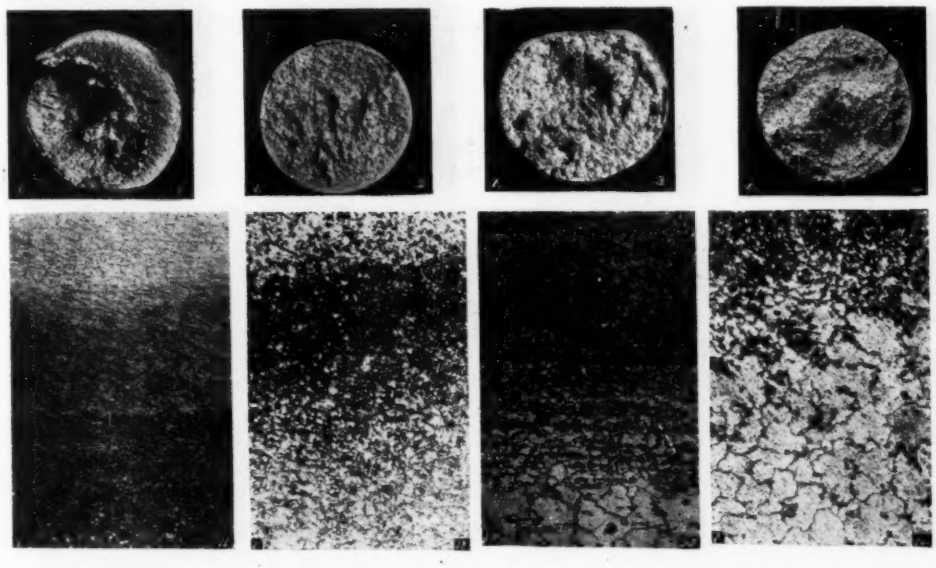
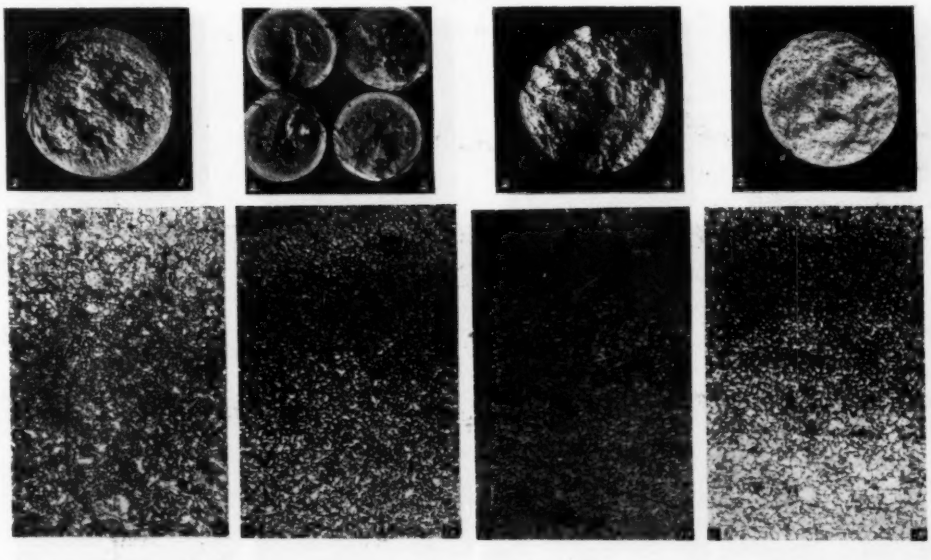


PLATE II.



Microscopic Examination.—This still reveals an abrupt demarcation between case and core even on Steel No. 2, which shows the best fracture.

Whilst Steel No. 1 is underheated, the rest of the series, except No. 2, are overheated.

Remarks.—Although Steel No. 5 has a granular core, it shows good impact value of 35 ft. lbs. associated with 71 tons tensile, but treatment No. 2 can only be regarded as suitable for Steel No. 2.

Treatment No. 3.

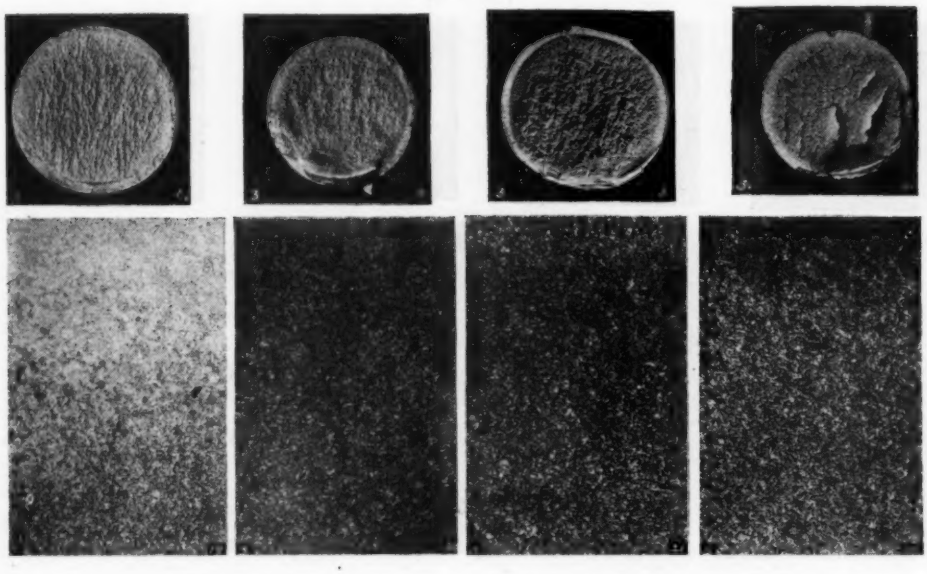
The third treatment, in which carbonising was

conducted at 870, followed by oil quenchings at 840 and 750 deg. C., failed to harden Steels Nos. 1 and 2, and even Steel No. 3, which showed 55 tons tensile with 58 ft. lbs., should be rejected, as it has a slightly granular case.

Steel No. 4, too, with 66 tons and only 28 ft. lbs., has a granular case, whilst Steel No. 5 is too soft.

Remarks.—It is understood that a properly hardened case-hardening steel must first be refined for the "core," and, secondly, refined for the "case," the second quenching being to "temper" the core. This is suitable for ordinary carbon case-hardening steel, of which critical point is above the second quenching temperature, and not below the hardening temperature of the case. For alloys, case-hardening steels, such as 3 per cent. or 5 per cent. nickel, however, their critical point is below the second quenching temperature, which produces a crystalline or granular core. It is difficult to realise why the second quenching is given by some tool-steel makers at about 750 deg. C., which is far above any critical point of these steels. On the other hand, it is not easy to carry out the second quenching satisfactorily below their critical point, because the case will not have the required hardness, although much harder than in the carbonising state. Therefore, it can be assumed that the temperature of 710 deg. C., water or oil quenched was the lowest permissible to obtain the required hardness.

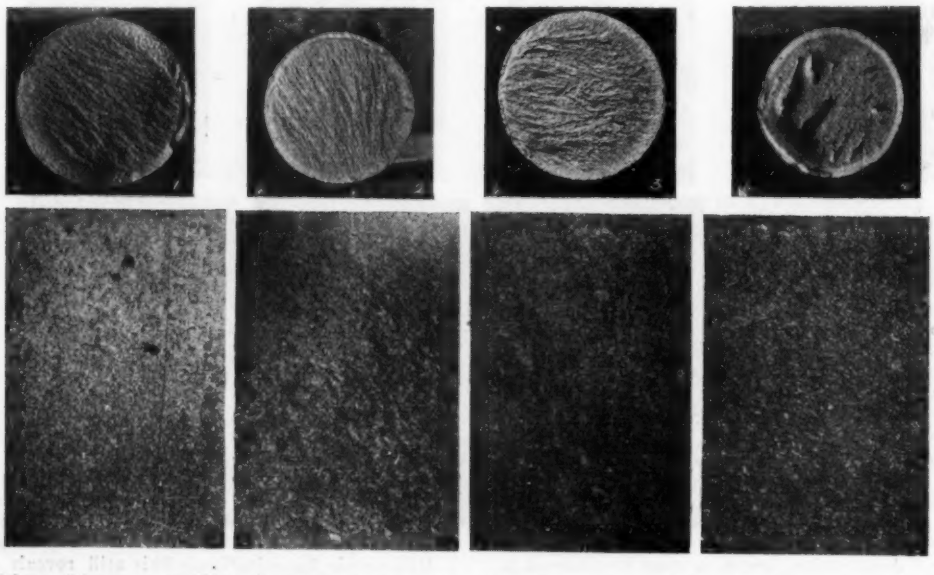
PLATE III.



Treatment No. 4.

Carbonising at 850 deg. C., associated with two oil quenchings at 760 and 710 deg., C., which constituted the fourth treatment, resulted in Steels Nos. 1, 2, and 5 having soft cases and their consequent rejection. Steel No. 3 had the same mechanical properties as in the third treatment, but with an improved impact figure of 75 ft. lbs., as against 58 ft. lbs. and a very fine grey case. Steel No 4 gave only 50 tons tensile, with an impact of 75 ft. lbs., and a fine grey case. The hardness is above the required figures. It can be assumed, therefore, that treatment No. 4 is suitable for Steel No. 3 and also for No. 4 if a 50-ton tensile is considered as sufficient.

PLATE IV.



Treatment No. 5.

For the fifth treatment carbonising was conducted at 850, the first water quenching being at 840 and the second at 710 deg. C. Only Steel No. 5 was submitted to the above treatment, owing to the fact that the case is too soft in the quenching from 710 deg. C. in oil, therefore both quenchings have been made in

water. The results are satisfactory, as will be seen by reference to Table V.

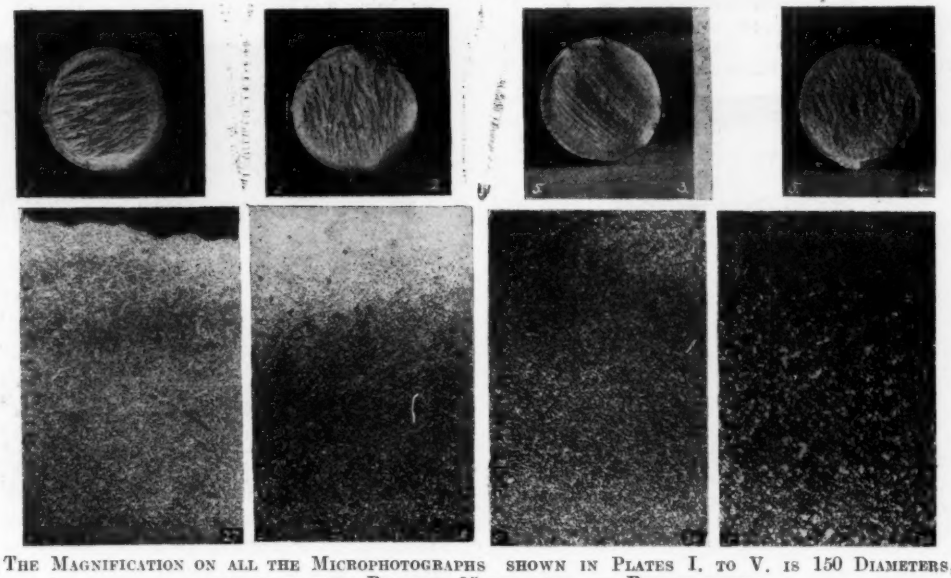
Treatment No. 6.

Here carbonising was carried out at 850, followed by water quenching at 760 and 710 degs. C.

Nothing much is to be gained from the above treatment, except slight improvements in the elongation and the Izod and Hardness figures. Treatment No. 5 is preferable for Steel No. 5.

The micro-photograph of the case of the nickel-chrome case-hardening steel shows that the cementite formed takes the shape of small nodules, termed spheroidal cementite. It is believed to be a double carbide of iron and chromium.

PLATE V.



THE MAGNIFICATION ON ALL THE MICROPHOTOGRAPHS SHOWN IN PLATES I. TO V. IS 150 DIAMETERS, BUT HAVE BEEN REDUCED 25 PER CENT. ON REPROD UCTION.

General Conclusions and Classifications.

Owing to the demarcation between the case and the core, Steel No. 1 can be used only for parts having continual friction, but without having to support any intermittent load or fatigue. The demarcation shown will cause the case to flake off from the core. Even in Steel No. 2 the demarcation is slightly pronounced, and limits the application of the steel to frictional parts having slight fatigue, but without any bending or torsion. Although the constituents of this steel are almost identical with those of Steel No. 1, the manganese is very much higher, and accounts for a lower critical point, and therefore a lower carbonising and first quenching temperature.

In Steel No. 3 there is no trace of demarcation between case and core, which allows of its use for parts having friction combined with medium heavy load, bending or torsion, whereas Steel No. 4 can be used for parts having heavy work.

Steel No. 5 is suitable for very heavily loaded parts, and should a still higher tensile test be required, an air-hardening steel is to be recommended. This will give a fine grey case with a core of medium length fibres.

The object of the above experiments was to show what must not be done in case-hardening; and, by means of illustrations, to detect at once what has happened to a part broken in practice. To the engineer, the aspect of a fracture compared with the different photographs of fractures shown will perhaps indicate the cause of trouble, whilst the metallurgist will be able to compare the microstructure with those reproduced.

Other Defects.

Additionally to the failures due to heat treatment, there are several other types of defects which can be classified as visible and invisible to the naked eye. Under the first enumeration there can be included deformation, warping, hardening cracks, external overlapping, flaws, soft spots detected with acid or a file, whilst imourities and segregation are defects requiring the help of the microscope.

Deformation and Warping.—As carbonising may be responsible for this, it is advisable that the parts should be normalised so as to destroy the overheating and set, while hot. The cause may be due to quenching. In order to overcome the difficulty it is necessary to have two jigs made—one for bars, broaches, spindles, etc., and another for disc gears and all circular parts.

The object of the first jig is to dip long and straight articles in the quenching tank whilst spinning, so as to ensure an even hardening, as well as to counteract any warping which might take place in one particular direction. For this purpose tongs have been fixed on a disc of steel, attached to a thrust bearing, the disc acting as a flywheel. A set of tongs of different shapes are made to suit the different parts to be treated. By means of such a jig all warping can be suppressed, even on broaches 3 ft. to 4 ft. long. Owing to the weight of the jig the hardener is compelled to quench all spindles vertically.

Fig. 1 shows an appropriate disc, which has been proved satisfactory with more than 2,000 large, thin and shallow cams on which no distortion has been ascertained. The working of the jig is easy.

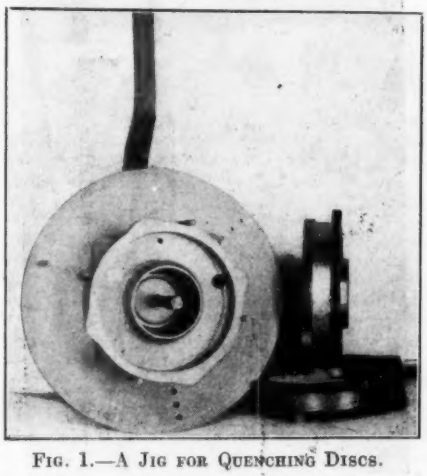


FIG. 1.—A JIG FOR QUENCHING DISCS.

Before the heating up, the part to be treated is assembled on the disc and pegs are fixed in the correct position, varying with the shape of the piece. When the part is ready for quenching it is taken out of the furnace by special tongs and fitted on the jig, whilst laid flat. The jig and the piece are taken up, and by means of the extra

peg revolved and quenched while spinning. As in the previous jig, the weight is sufficient to keep it in the vertical.

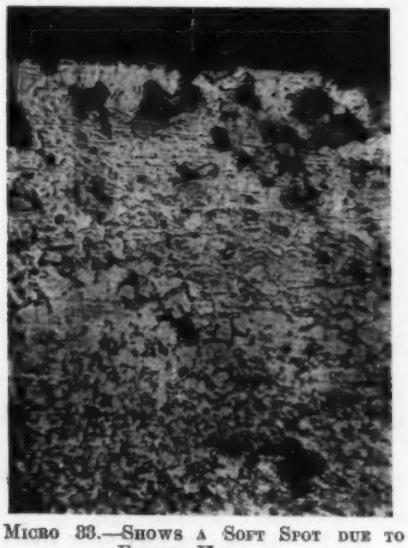
Soft Spots.—These are detected by filing after sand-blasting or after grinding by dipping in a 5 per cent. nitric acid solution in alcohol for about

MICRO. No. 31.—CASE SHOWING SPHEROIDAL CEMENTITE 500 DIAMETERS.

MICRO. 32.—SOFT SPOT ON THE CASE DUE TO HIGH PERCENTAGE OF SULPHUR.

10 seconds. They are produced from two different causes:—(1) Faulty compound, (2) faulty handling in the quenching operation.

By the acid test, soft spots due to the first cause are whiter in colour than the hard surrounding sections. From the second cause, the etching will show the softer portion very much darker than the surrounding harder parts. These differences in colouration are due, in the first case, to faulty compound, because the soft spot is of the same nature as the core, *i.e.*, 0.12 per cent. carbon, this being due to the absence of penetration, whilst the hard section contains 0.9 per cent. carbon. If drillings of these two steels are dissolved in two test tubes, with the same volume of nitric acid, it will



MICRO 33.—SHOWS A SOFT SPOT DUE TO FAULTY HARDENING.

be noted that the steel containing a higher percentage of carbon gives a much darker solution than the one containing only 0.12 per cent. Therefore, in the acid test described above, the same action takes place, i.e., portion lower in carbon will be lighter, while portion darker will contain a higher carbon content.

Soft spots may be due to impurities contained in the compound, as very often barium carbonate containing a certain amount of barium sulphate is used. The sulphate is reduced to sulphide during the carbonising operation according to the following reaction:—

$$BaSO_4 + 2C = BaS + 2CO_2.$$

From microphotographs Nos. 32 and 33 it will be seen the ill-effect produced on the case, which, although containing a high percentage of carbon, remains soft, owing to its higher percentage of sulphur.

In the second case, the darker portion is soft—this being due to faulty hardening, through the

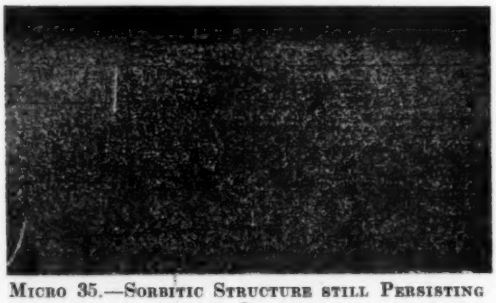
MICRO 34.—SOFT SPOT, OWING TO FAILURE TO PRODUCE MARTENSITIC STRUCTURE.

agency of dirt or cold tongs—whilst the lighter portion is hard.

As previously noted, 0.9 per cent. carbon steel gives a dark colouration when attacked by nitric acid, but if three pieces of this steel are taken, one being annealed, one hardened, and one tempered, the first will have a pearlitic, the second a sorbitic, and the third a martensitic structure. After polishing and etching each one of these steels with the nitric alcoholic solution for 15 seconds, it will be shown that the harder the steel the lighter the colour. Therefore pearlite will be dark, sorbite not so dark, and martensite quite light compared with the two first.

The case after hardening is pure martensite, and if by any means the sudden cooling is stopped, the martensitic structure will not be produced. The new structure will be either pearlite, troostite or sorbite, all of which etch much quicker than martensite.

In order to show the difference in structure,



MICRO 35.—SORBITIC STRUCTURE STILL PERSISTING AFTER QUENCHING.

reference is made to microphotographs Nos. 34 and 35, which are typical—No. 34 showing the first cause, whilst No. 35 demonstrates the second.

It is possible, however, to have soft spots in the same piece, due to both compound and faulty hardening. In such a case three different shades will be noted.

To restore such a piece it is necessary to clean or sand-blast and re-quench it. In practice and for mass production, the acid test will be rather a lengthy and expensive test.

Some Experiments on Pouring Castings Without Runners.

By Harold Measures.*

In the last issue of THE FOUNDRY TRADE JOURNAL there is a very interesting article by E. Ronceray, which originally appeared in a recent issue of "La Fonderie Moderne," the translation of which has been made, the whole matter carefully studied conjointly and by the writer and his foundry manager, Mr. George Hall, who has been responsible for the carrying out the experiments.

Reading the article from a practical point of view, and not dealing too much with the scientific or technical points, there is much to be said in favour of the system advocated by M. Ronceray, but it is necessary to elaborate the whole matter

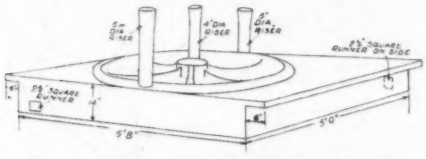


FIG. 1.—SHOWING THE METHOD ADOPTED FOR CASTING A BASE-PLATE WHICH GAVE SATISFACTORY RESULTS.

by a great many more experiments than those dealt with in the article or by the author's work upon this subject.

Undoubtedly, science is not sufficiently brought to bear on foundry practice, but in this article it is only proposed for the moment to deal with the practical side.

Speaking, firstly, from the point of view of the practical moulder, there is much which commends itself in the system advocated by M. Ronceray, but it is rather difficult to make everything quite clear when dealing with a foreign language on technical questions, as is expressed by M. Ronceray himself in his own comments on the Brunelli system. In the particular comments to be set

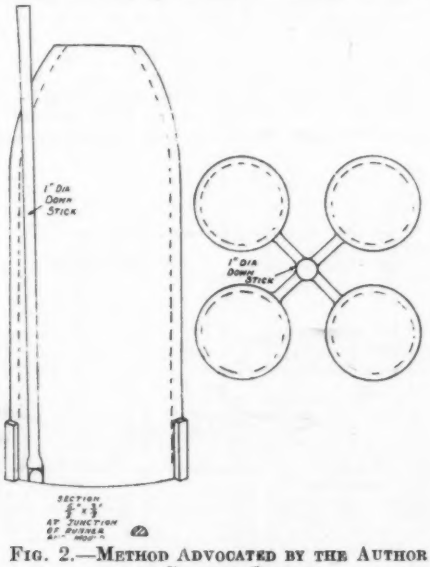


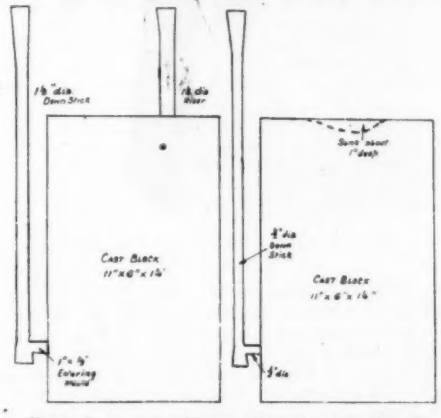
FIG. 2.—METHOD ADVOCATED BY THE AUTHOR FOR CASTING SHELLS.

forth the same position arises, and therefore bringing in the possibility of losing the technical sense indicated, resulting in illusory differences. This article is given not with the object of creating an argument, but with the object of gaining knowledge from experiments by practical men and means.

Undoubtedly, many castings are best poured at the bottom, or on the side near the bottom of the casting. The evidence so far gained does not agree with M. Ronceray's on the question of slow pouring, especially in the case of a casting that has to be machined all over, or even to withstand pressure, for the reason that when once the metal commences to flow into the mould the sooner the mould is filled the better the result in general. At the time of writing a casting is lying in the foundry over 5 tons in weight. From the time the metal commenced to flow into the mould until it came up the risers the time taken was not more than two minutes. That casting will bear investigation by any engineer or foundryman. There is no sign of porosity under the runners or risers, and it is noteworthy that in parts of the casting the metal is 14 in. thick, solid. The casting is shown in Fig. 1. It will be seen that the casting had three risers about 5 in. dia. 18 in. high, and two runners 3 in. dia. Does M. Ronceray maintain that his method would be a success in castings of this kind? The question is asked, because experience has shown that slow pouring often causes the sand to scab off, gives porous castings, and results in a very dirty top to all castings.

Comment on running a jet down the centre core is needless, because it is quite an old and familiar practice, and can only be carried out where the core is sufficientiy large to take the jet, but for the general system, whether the jet is at the side or in the centre, it should answer the same purpose as individual castings may require.

Nor do we pretend to discuss the merits or advantages to be arrived from the filtration of metal in Messrs. Lelong & Mairy's principle, because



FIGS. 3 AND 4.—PLATE CASTINGS. FIG. 3 IS CAST BY THE AUTHOR'S AND FIG. 4 BY M. RONCERAY'S METHODS.

it is far too expensive for general practice: it may be quite satisfactory where expense is a minor factor.

M. Ronceray rightly says that in founding there are many things we do not know. For instance, we are ignorant of the absolute law of contraction of the metal, etc., and, further, from the article, it seems as though much thought has been expended on the number of expansions during cooling and solidification. However, it is possible that great variations may take place simply in the method by which the pouring is done, and we agree that it can be carried out in connection with contraction by the use of the pyrometer, which gives the approximate temperature of the metal in the ladle or in the furnace, but this would not in any way overcome the difficulty which M. Ronceray deems to be of outstanding importance.

It is common knowledge that the metal does not contract until it commences to solidify, and it must be borne in mind that the hotter the metal when poured the greater is the pressure on the mould, consequently the contraction would be less with hot metal than with cooler metal. This leads to the suggestion that if designers of machinery would study the foundry trade a little more, as M. Ronceray suggests, that is, academically, technically and practically, many fractured and distorted castings would be obviated, as defects are generally caused through unequal thicknesses,

* Mr. Measures is a partner in the Croydon Foundry Company.

which could be avoided on many machine parts. A good example of this is shown in Fig. 2, which is a type of casting which created much difficulty at some of the largest foundries during the war. It will be seen that the shell casting, as in most shells, is thickest at the bottom. The first practice was to cast these bottom uppermost, and one of the most important foundries in the country experienced considerable difficulty through porosity at the base of the shell. From the sketch it will be seen that the method advocated is to make the shells with the point uppermost, and the runner at the bottom, exactly on M. Ronceray's principle of no riser, but directly opposed to his method of thick part uppermost. Considering that thousands of these were cast weekly without any wasters, excepting normal foundry accidents, it is conclusive proof of the practical value of this method of casting, as certainly not more than 1 per cent. of the shells failed under hydraulic pressure test of 100 lbs. per sq. in. The metal used in runners certainly did not exceed 8 per cent., and no risers were used.

There is mention made that the gases can be evacuated through the sand, and whilst agreeing with the point in the main, it must not be forgotten that many castings are wasters because the sand is too solid to allow of the gases and air escaping from the mould whilst filling with metal,

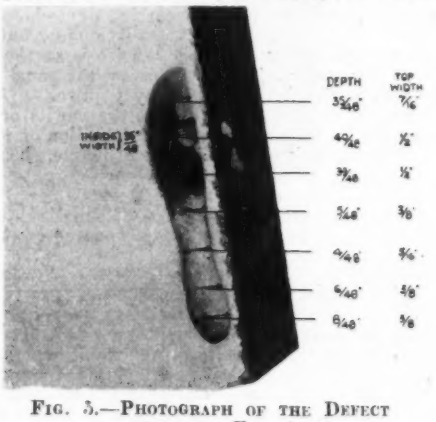


FIG. 5.—PHOTOGRAPH OF THE DEFECT SHOWN IN FIG. 4.

and this would seem to bear to some extent on a casting of uniform thickness, which M. Ronceray does not recommend for his practice. Figs. 3 and 4 clearly confirm this. They show a plate, which, in the case of Fig. 3, was cast with the ordinary runner and riser, whereas, in the case of Fig. 4, the plate was poured by means of a thin sectioned runner and without riser.

The first method resulted in a sound casting, whilst the second showed porosity at the top, but, provided the sand is homogeneous and properly vented either with a vent wire or fine coke mixed with the coal dust, most of such wasters would not occur. Fig. 5 shows photographically the defect shown in Fig. 4.

We do agree with M. Ronceray's statement that a casting of uniform metal thickness would not be satisfactory under his system, no matter what the porousness of the sand, unless risers were used, and this really answers a question which M. Ronceray asks, viz: "What necessity is there for employing runners and vents?" Here is one case where we say a vent is absolutely necessary, and must be in the form of a riser.

The suggestion that a certain amount of waste metal is saved in runners and risers is certainly one to be considered, but at the same time if all castings were cast with a bottom runner the writer fears there would be very little profit on a casting at the present market price of cast iron. The saving on cost of metal would be swamped by the extra cost incurred in moulding and in making bottom joints to cut-in the runner, and it is really a question for the highly skilled moulder to be able to judge the best place for both riser and runner. Though holes and porosity are sometimes found under a riser, the reason generally is not far to seek, and is that the riser is too small, or the metal insufficiently hot, or inefficient feeding.

Referring to the paragraph dealing with depressions, it cannot be substantiated that it is necessary to put extra metal on the top of the castings. If the riser is correct in shape and size it is more advantageous to have this riser and cut it off afterwards than to have extra metal all over the top

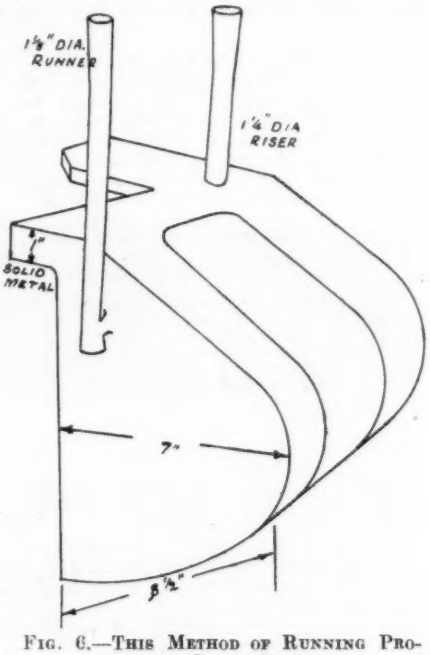


FIG. 6.—THIS METHOD OF RUNNING PRODUCED A SOUND CASTING.

which has to be machined off, consequently incurring much expense in providing for sinking. It is understood that M. Ronceray says that this is only a probable difficulty. The casting shown in Fig. 1 is of the type where depressions might easily take place, but this in particular, however, shows no sinking of any description.

The reference to the re-use of sand is not one which we think it necessary to discuss, because it should be understood that old sand should always be re-employed in fixing sand, which point is governed by the sand mixer, who, if he does not know what sand to use, or how to mix it, no good casting can result. Even burnt sand could be used if properly applied and mixed with some of the good core binders which are now on the market.

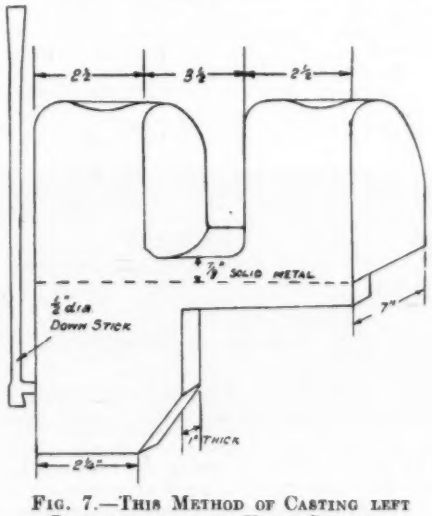


FIG. 7.—THIS METHOD OF CASTING LEFT DEPRESSIONS ON THE UPPER SURFACE.

Fig. 6 is a casting of varying thicknesses, poured quickly and provided with a riser on the thick part, which turned out to be sound. Fig. 7 is the same casting, but made without a riser and poured slowly by means of a small runner, according to M. Ronceray's method. This resulted in a waster, as on the top of each thick part there is a depression which can readily be seen on the sketch.

Making Castings for Internal Combustion Engines.—Part II.

Moulding a Water-Jacketed Cylinder.

By "Ben Shaw" and "Jas. Edgar."

The expression sound casting has a very special reference to those castings which are required for internal combustion engines. The most important castings in this class of work are, undoubtedly, the cylinders, and, although designs vary in their intricacies, the simplest types, as well as the more complicated, must be sound when cast. In many other classes of work involving castings having much thicker metal the term soundness, though desirable, is not of quite the same importance, as frequently flaws and imperfections in such a casting do not affect the ultimate value of the work for its specific purpose. When the metal section is thin, the casting complicated, and the nature of the work the cylinder is required to perform is heavy, then the term sound has a special significance and imperfections which would be of minor importance in other castings assume larger proportions and become factors which cause their rejection. The intricate design and the exacting demands made upon these comparatively light castings considerably increase the difficulties with which the moulder and foundryman are confronted in producing castings to fulfil all the requirements.

In many foundries making a speciality of this class of work the percentage of wasters is relatively high, and, while it is not possible to eliminate bad castings entirely, by careful consideration of the factors which are involved in their production the difficulties may be largely overcome. Complicated work of this nature demands considerable skill and initiative in devising the most successful method of preparing the moulds, determining the most suitable core sand mixture to form the delicate cores required for the water jacket, and strong enough to resist the liquid pressure of the metal; the method of securing the cores after they have been set, and the most satisfactory means of venting them. It necessitates experience and discernment to determine the type of runners used where the metal should enter the mould and the character and quality of the metal which is supplied. It is the careful consideration of these factors which is so essential in the production of sound castings.

There are many types of internal combustion cylinders and a considerable variety of designs for each type, and as the design and types vary so will it affect the method of their production in the foundry. It is not possible therefore to deal with the various forms, but, by considering the methods employed in the making of the cylinder casting for a representative form used for road transport the underlying principles involved in their production may be helpful in the consideration of other forms of this class of work.

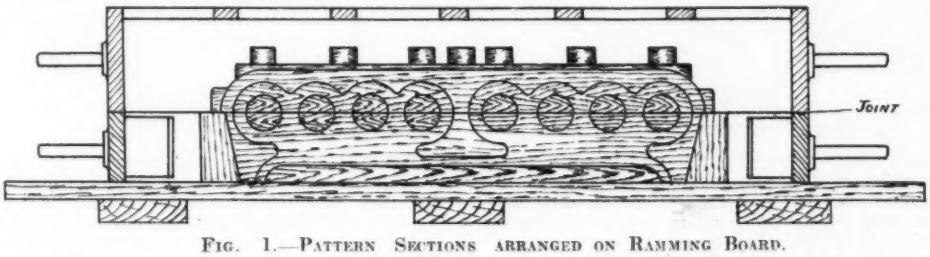


FIG. 1.—PATTERN SECTIONS ARRANGED ON RAMMING BOARD.

Many foundries cast these cylinders in green sand, while others prefer dry-sand moulds. The form preferred generally depends upon the complicated nature of the work, and, in a smaller degree, the facilities of the foundry and the number of castings required.

Less complicated castings can be satisfactorily made in green sand, but the more intricate the design and the thinner the metal the greater the possibility of wasters resulting from its use. Considerable discretion should therefore be shown in the selection of the form of moulding which will give sound castings with the minimum percentage of wasters. Generally, dry sand moulds give better castings, but it increases the production costs. The percentage of loss is, however, lower, and this fact compensates in some measure for the additional cost of preparation.

When the number of castings required warrant the additional expense the pattern sections may be mounted on plates, then special boxes must be prepared, particularly for the middle part. The top section of the pattern can readily be located on a standard wood or metal plate, but both the middle part and drag necessitate the preparation of a plate carrying the varying shape of the joint. For a cast plate it would be necessary to prepare

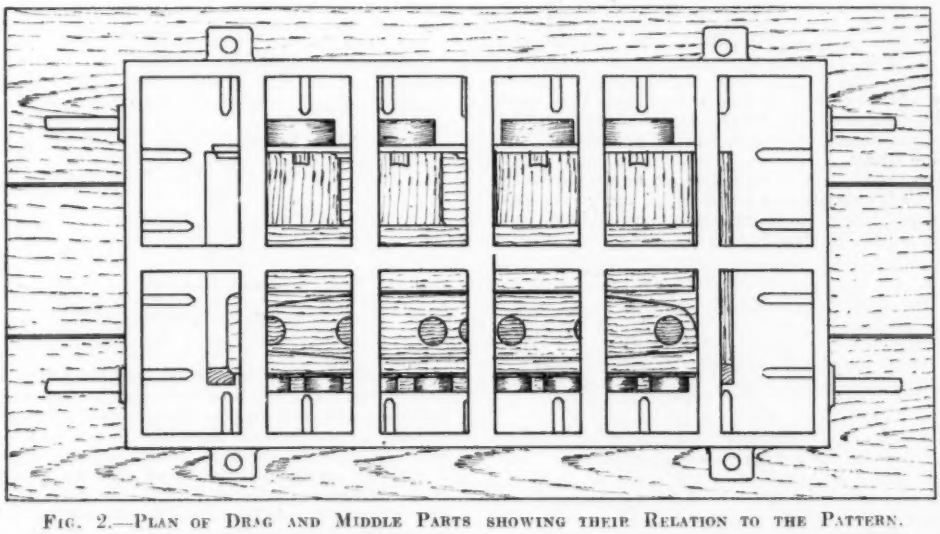


FIG. 2.—PLAN OF DRAG AND MIDDLE PARTS SHOWING THEIR RELATION TO THE PATTERN.

the joint from the pattern in a larger box part, and after making up the part actually taken up by the pattern, when it has been withdrawn, an impression is taken of the joint in a cope part. A frame, with external dimensions and thickness similar to desired plate, may then be located about the joint and the outer edge made up to the level of the frame with sand so that when the cope is replaced the two surfaces forming the joint will be separated by the thickness of the desired plate: this provides the mould, and with suitable gates the metal can be poured into it.

When the casting has been cleaned up and arrangements made for locating it on pins, the pattern sections may be secured to their respective sides of the plate. With a plate of this character carrying pattern sections on each side, it is necessary to prepare the drags, making the number it is desirable to cast in one day, and then arrange the plate for the middle parts to be made. The copes may either be made on a separate machine or the same machine may be rearranged to accommodate the top pattern section. While this rotation in their preparation is advisable when the moulds are to be dried, it is essential when they are made in green sand so that the operation of coring may proceed without undue delay.

The production of these moulds mechanically has many advantages over hand moulding, as the sand is more likely to be regularly consolidated, and with a pattern drawing devise, there is considerably less wear and tear of the pattern. Furthermore, the machine can be operated. The number of castings capable of being made in any one day, even though a moulding machine may be used, is governed largely by the speed of coring up each mould, and, when there are a number of very delicate cores involved, more time is occupied in fitting the cores accurately in their respective places and closing for casting than in the preparation of the moulds.

Frequently this type of cylinder is prepared on the foundry floor mainly because the number capable of being prepared in a day feed the other departments as quickly as is considered desirable.

The method herein described covers that which would be suitable for floor moulding, the variation necessary to make use of a machine not affecting the principles involved excepting that the pattern sections would be mounted and the three parts would be made separately.

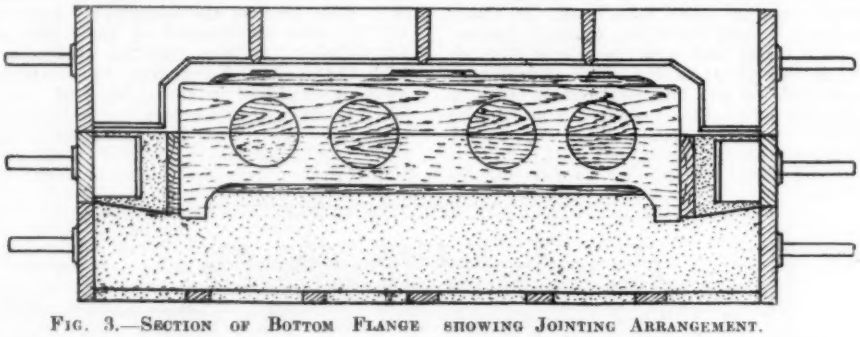


FIG. 3.—SECTION OF BOTTOM FLANGE SHOWING JOINTING ARRANGEMENT.

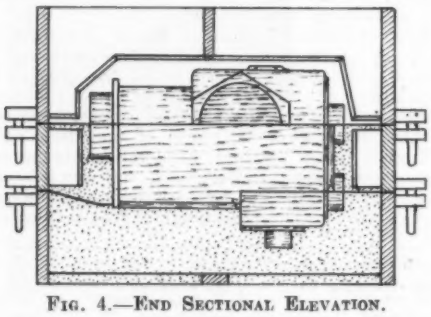


FIG. 4.—END SECTIONAL ELEVATION.

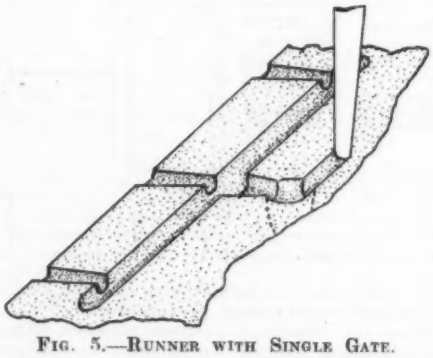


FIG. 5.—RUNNER WITH SINGLE GATE.

The joint of the pattern between the top and middle parts coincides with the joint of the mould, therefore the middle section can be laid on a moulding board in an inverted position. A middle box part, having a depth equal to the difference between the centres, or as near as possible, is used to surround the pattern, as shown in Fig. 1. It is necessary to have short bars about the inside of the part to support the sand. When this has been rammed up it is required to form a joint which varies slightly from that of the pattern. The usual method is to follow the centre of the valves and then rise to the back flange. When this has been prepared the drag part can be located on the middle box and this part of the mould rammed up. The arrangement is illustrated in Figs. 1 and 2. Both parts must now be rolled over to proceed with the cope part, but it is advisable to secure the boxes together before they are moved. The relation between the pattern and the box parts and also the formation of the joints looking at the bottom flange is shown in Fig. 3, and an end elevation is indicated by Fig. 4. Before an attempt is made to ram up the cope it is necessary to determine the position of gates and risers. Special precautions should be taken to prevent scum getting into the mould with the metal, therefore skimmers should be provided at the joint of the joint as a final safeguard. Gates within convenient distance of the cylinders and suitable for supplying metal between them is very suitable for this type of cylnder. There should be as little movement of the metal about the water jacket as possible, hence pouring by way of the bottom flange gives this desirable condition. One large gate may be used in the centre, supplying a runner having sprues cut to the mould, as is shown in Fig. 5; or three gates may be used, each having

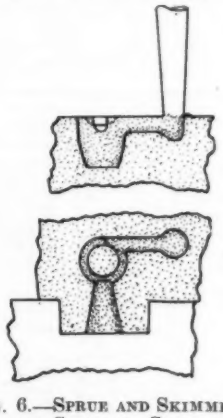


FIG. 6.—SPRUE AND SKIMMER FOR SEPARATE GATES.

its own skimmer and sprue, as in Fig. 6. The use of a single gate changes the position of the runner to the joint of the mould, whereas the three single gates are supplied from one trough outside the mould. The single gate is usually preferred, but the sketches illustrate the use of three in order to emphasise the need for skimmers.

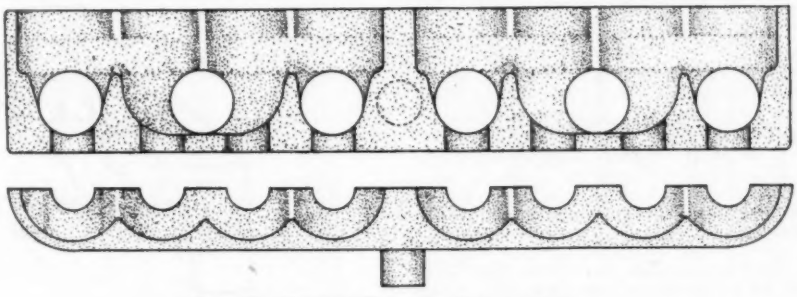


FIG. 7.—BOTTOM PART OF JACKET CORE.

When the position of the gates have been decided and riser sticks set on a number of the high parts of the pattern, the process of ramming the cope part can be accomplished.

The sand used for the mould should be of medium grade and of a porous nature. The use of a vent wire is necessary, especially in the drag, even though a dry-sand mixture is used. It is, of course, more essential if a green-sand mixture is being used, particularly with regard to the drag, so that the thin metal is relieved, as far as possible, from the pressure of gases formed during the time of casting.

When the cope is finally rammed and the gates and risers withdrawn, a commencement can be made to strip the mould. This involves considerable care, as a clean withdrawal of the pattern is of vital importance in work of this character. When the mould is to be dried swabbing is an advantage, but for green sand the swab should not be used. Before the middle pattern section is withdrawn the runners and sprues should be cut and practically completed, so that all surplus sand may be removed from the joint.

When all the pattern work has been taken from the mould and the runners finally made up, the various box parts should be reassembled so that each part is separated by about 1 in. or 1½ in., and conveyed to a drying oven. Usually, when dry-sand moulds are preferred, special arrangements are made for conveying the desired number of moulds for each day's work.

In green-sand castings the skin is considerably improved by the application of plumbago; it is preferable to spray it upon the mould rather than merely dusting it on. Some foundries resort to skin drying, but it is of little value in work of this kind, because so much time is occupied in coring that the effect is lost.

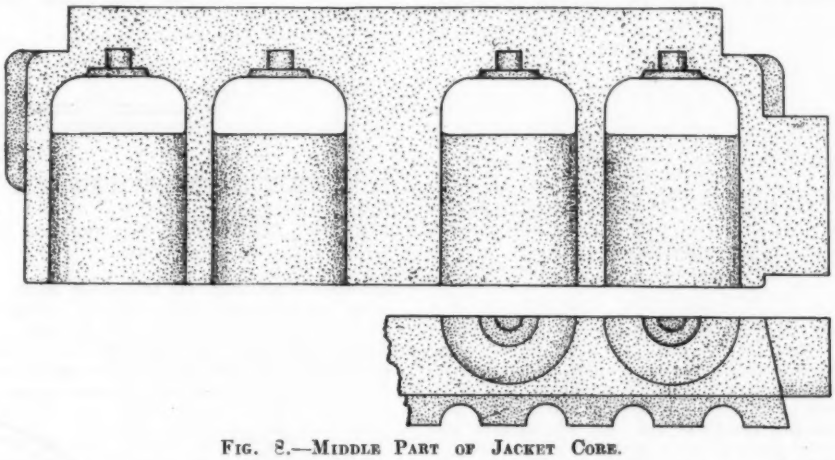


FIG. 8.—MIDDLE PART OF JACKET CORE.

Whilst considerable care must be exercised in the formation of suitable moulds, these qualities must be observed to a greater extent when dealing with the cores. However good the mould may be, and however high the quality of metal which it receives, the composition and formation of the cores provides the key to the solution of many of the difficulties experienced with this class of casting. To persist in the use of a naturally bonded sand for such delicate cores is courting trouble; uniformity can only be obtained by the use of an artificially bonded sand. Linseed oil is undoubtedly the strongest and most efficient binder for this purpose when used in conjunction with a clean silica sand. This bond has a body which is desirable, and it is tough.

Usually the oil is emulsified with water, and it must be so thoroughly mixed with the sand that each grain is uniformly coated with the mixture. This composition reduces the need for venting the

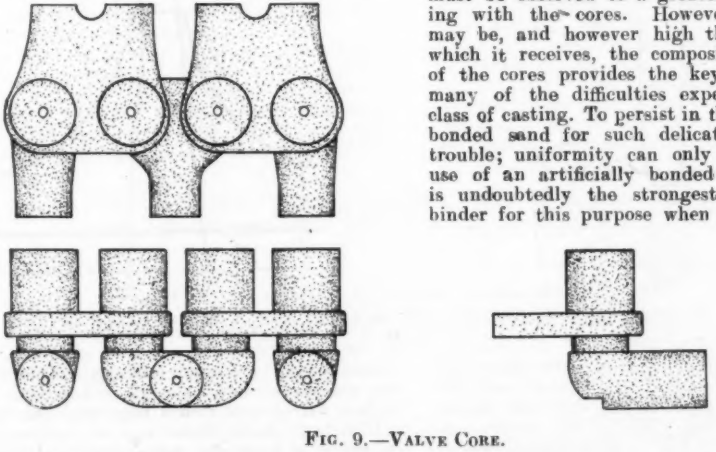


FIG. 9.—VALVE CORE.

cores; as, when dried, it is very porous and practically self-venting; furthermore, the need for intricate arrangement of strengthening irons is not so essential—a very important consideration in fettling the casting. With a composition of this nature the bond is carbonised by the heat of the metal and the sand becomes disintegrated, and, when the casting has cooled, there is little difficulty in removing it. The core-boxes should be wiped clean for each core, as the use of this binder has a tendency to stick to them. This difficulty can be largely overcome by rubbing the surface of the boxes with graphite. Irons should be prepared for each box as a template, so that they may be duplicated for each core.

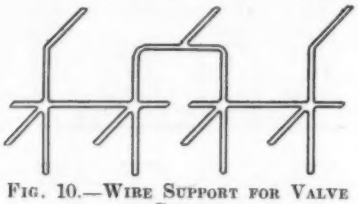


FIG. 10.—WIRE SUPPORT FOR VALVE CORE.

Thin pieces of iron bent to the shape will suffice; in some instances pieces may be wired together, but consideration must be given to their removal from the finished casting. The most delicate of these cores is that required for the water-jacket, and the fact that it must be prepared in three pieces makes it more fragile. The first of these cores to enter the mould is shown in Fig. 7. Two pieces of soft iron following the shape, and almost the full length of the box, will answer the purpose if a piece of wire is attached to them for the part of the core which penetrates the metal. During the process of ramming this core, and after the irons have been bedded in the sand, a few pieces of wax venting, laid in with their ends terminating at the end of the outlet core, will assist the escape of gases in the direction desired at the time of casting. The middle part of the jacket core, shown by Fig. 8, is not quite so delicate, and it has a larger outlet. In this instance the removal of irons is not so troublesome as long as the ends are within easy reach of the outlets. Two long pieces shaped to the contour of the core, and having cross-pieces wired to them, will give all the strength needed. Wax vents may be introduced in this core also, with the object of aiding the escape of gases from the bottom core. The top jacket core is less intricate, but the valve cores need considerable care. Three views of this core are shown in Fig. 9. A little more care is necessary in strengthening this core in order to maintain its rigidity. Wire bent to the shape indicated in Fig. 10 will give all the strength required, providing the wire is about ¼ in. to 3-16 in. diameter. This form of stiffener can easily be withdrawn from the casting, but rodding may be used equally as well if the pieces are sweated together to give the necessary shape. The four cylinder cores (Fig. 11) are easily made. A single wire rod will give the required strength, but a little care must be exercised to obtain a sound junction between the small part of the core, which penetrates the top end of the cylinder, and the main body, to avoid cracking. This precaution is necessary, not so much for setting the core when fitting the mould together, but to prevent it lifting during the time of casting. In the making of both the valve cores and the cylinder cores, wax vents may be used with advantage to give a clear outlet from the centre of the cores. One of the end cores required to enable the middle section of the pattern to be withdrawn more easily is illustrated by Fig. 12. Two pieces of wire are shown for convenience in lifting; these are attached to the irons introduced in the core. The

FIG. 11.—CYLINDER CORE.

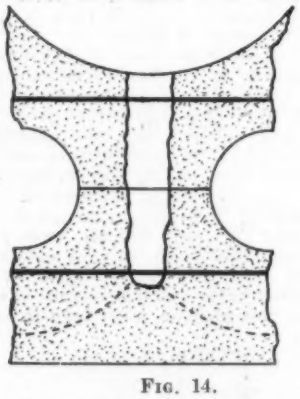


FIG. 14.

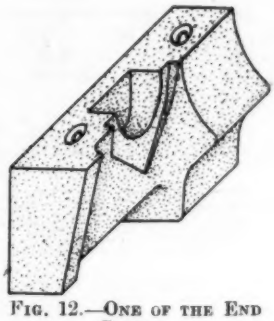


FIG. 12.—ONE OF THE END CORES.

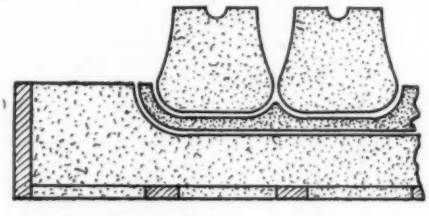


FIG. 13.—PART SECTION THROUGH VALVE CORE.

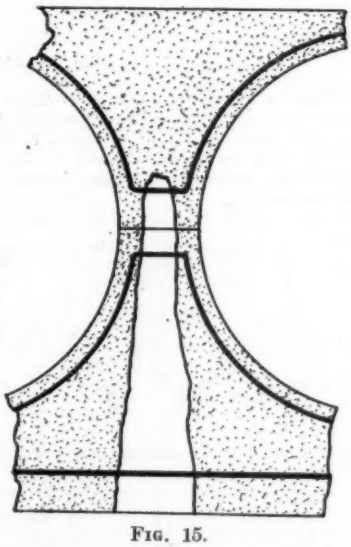


FIG. 15.

FIGS. 14 AND 15 SHOW THE ARRANGEMENT FOR SECURING THE VARIOUS PARTS OF THE JACKET CORE.

venting of these cores is not so important, as almost the whole area comes into contact with the mould; it is necessary, however, to ease part of the core away where the vent from the water-jacket core coincides with it.

To encourage speed in the production of the necessary cores, some arrangement for supporting the cores after they are made is essential. Practically all artificially bonded sands are weak when green, and the use of linseed oil or compounds with linseed oil as the base are not exceptional in this respect. To use part of each core-box as a support until each core is almost dry slows down the operations of the coremaker and

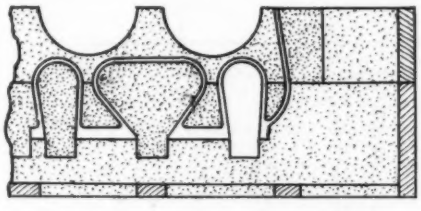


FIG 16.—SECTION THROUGH VALVE.

retards production. When quantities are required it is profitable to prepare sheet-iron stampings, so that the cores needing support may be turned into them and transferred to an oven.

When the moulds have been dried, a wash composed of equal parts of blacking and plumbago, and having a little gum incorporated, should be applied and again dried. The use of a wash is valuable, not only in giving a good skin to the castings, but in causing the sand to peel more readily when they are being cleaned.

With the cores and mould dried, the operation of assembling can proceed. Considerable care and skill is required, especially when fitting together the first few of a new type. If the practice of making a set of cores to test the accuracy of the core-boxes has been resorted to, then the difficulties will be considerably reduced, otherwise discrepancies are likely to occur. The bottom part of the jacket core must be located first, and, as this core has only one outlet through the bottom, and that comparatively small, chaplets may be used at convenient places to assist in the setting and to maintain it in its relative position. The use of chaplets in this class of work should be limited as much as possible, and they should not be used on faces which are to be machined. Very light perforated chaplets are suitable, and they should be secured to the mould. The valve cores are the next to be inserted. These cores have prints in the bottom of the mould and on the joint, hence they are more easily set. A part section of the drag with these two cores in position is shown in Fig. 13. The middle box part can now be returned to its former position and the second water-jacket core placed. The setting of this core necessitates care, as the end core carries a part impression of one of the outlets. These cores must be lowered in together, because the projecting valve cores will only allow the jacket core being lowered vertically.

It is preferable to secure the jacket cores as each one is finally placed, and provision should be made for wiring the parts. An enlarged part section of the junction between these two bottom parts is shown in Fig. 14, having a small amount of core sand removed to bare the irons. Wire can be passed round these and the hole filled. A similar method of securing the two top parts is shown in Fig. 15. If a few convenient places are wired in this way, the joint having been previously daubed with linseed oil, the parts will maintain their relative position better, and the best use is made of the prints for supporting the whole core. When the middle jacket core and both end cores are set they should be tested with a straight edge, as the top of these cores ought to coincide with the joint of the mould. Fig. 16 illustrates a part section through a valve core showing the relative positions of four cores, and the left of Fig. 17 shows another view of the same cores looking on the joint of the mould. The four barrel cores can now be located, resting on the valve cores and in the print impressions, as shown on the right of Fig. 17. The vents should be made clear to the side of the box.

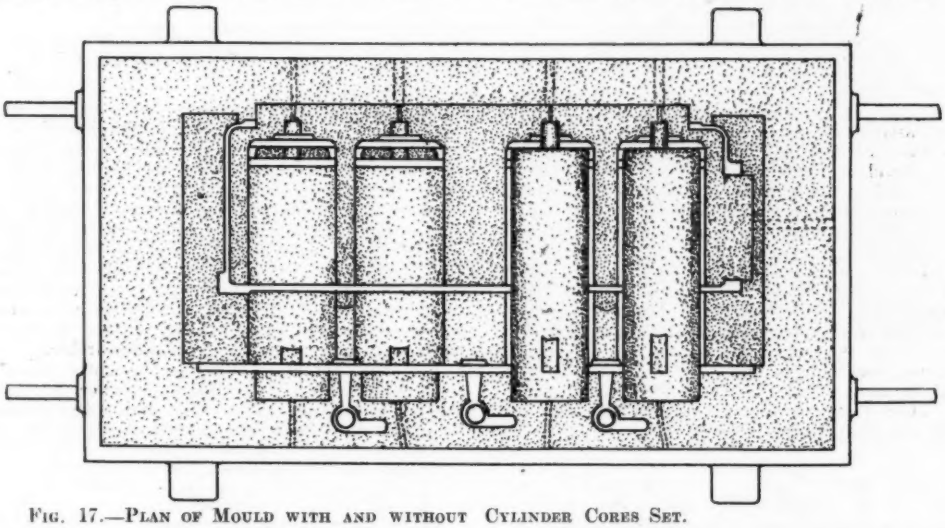


FIG. 17.—PLAN OF MOULD WITH AND WITHOUT CYLINDER CORES SET.

A template similar to that shown in Fig. 18 is helpful for testing the correct heights before setting the last core. The remaining part of the jacket core has only the shape of the middle part as a guide, so that care must be exercised in placing it. With the first few moulds it is preferable to test the thickness between the cope and the water-jacket core before it is secured to the other part. For this purpose plastic clay will suffice, a few bits being placed conveniently on the core and the cope lowered. It is necessary to note that the ends of the prints are tapered well back from the joint. While the cope is in position it is well to test the gates with chalk. The cope having been removed and the thickness of clay found to coincide with the required thickness of the metal, the core can be finally secured. When the first few moulds have been tried in this way and found correct, the practice may be neglected with the remaining moulds and only resorted to when there is a question whether the required thickness is not likely to be secured. A plan of the mould with all the

FIG. 18.—TEMPLATE FOR TESTING CENTRE CORES.

cores assembled is shown in Fig. 19, and a part section through one of the valves is illustrated in Fig. 20. The other part section shown in Fig. 21 shows the arrangement of the cores clear of the valve chamber. The three small cores which should be introduced to cut through the top thickness of metal may be either carried with the main core or their positions defined by impressions in the jacket core; in either case they should be made just long enough to allow the cope to touch them without the possibility of crushing. These three cores, together with the projections of the jacket core into the mould, are not sufficient in themselves to provide against the possibility of a lift

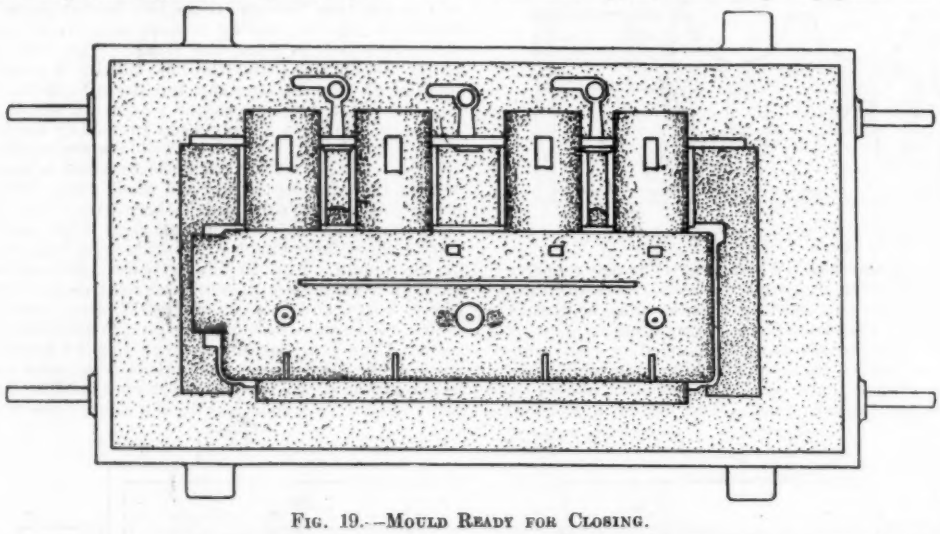


FIG. 19.—MOULD READY FOR CLOSING.

when casting, it is therefore necessary to introduce two or three chaplets, as shown in Fig. 19. They should be attached to the core just before finally closing the mould.

In preparing these moulds for casting it is necessary to prepare the trough or runner carefully. It is profitable to make it a reservoir for the metal, and, whether a single gate or the three gates are used, to prepare it for stoppers similar to that shown in Fig. 22. There is a double advantage in the use of such stoppers in this class of work; they prevent the molten metal entering the mould until the reservoir is full, thus the slag in the metal is most likely to remain in the runner, and, when the reservoir is full and the stoppers lifted simultaneously, a head of metal is main-

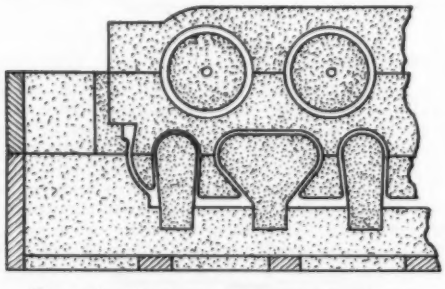


FIG. 20.—SECTION SHOWING POSITION OF CORES.

tained until the job is cast, this assists materially in the successful filling of the mould and reduces the possibility of the metal being cold shut. These runners should be prepared in a frame and dried, and preferably washed with blacking. The risers may be prepared for by simply using bushes, only two are shown, and these are from the thickened places for studs on the top facing. Others may be used from the flange, but if a number of needle vents are used at convenient places about the top of the mould the need for additional risers is not so essential. When the runner and risers have been grouted into position, weights may be applied or the mould clamped together ready to receive the metal. Fig. 22 shows two cast-iron bars laid across the mould to support a larger weight. Some foundries prefer to clamp their work, it being more convenient when many are to be cast. When this method is adopted it is better to use screw clamps rather than those necessitating wedges, as the violent jarring of the mould due to driving the wedges may cause damage.

It will be observed that the method described covers that required when the valve face is moulded and cast down. At first sight the casting of the valve face uppermost might occur to the reader. Such a method would dispense with the need for end cores, and a better bearance would be provided for setting the water-jacket core. The successful setting of the valve cores, however, presents a very real difficulty, as, even though top prints are disregarded, the fragile ends of the barrel cores would need to support them, the setting would be less accurate, and there would be greater difficulty in them maintaining their true relative position when the cope is lowered. Casting on end, while it is profitably used in the making of air-cooled cylinders, is not so convenient for those which are water-cooled, the difficulty frequently being the setting of the jacket core so as to prevent any possible movement when casting. Such a method would necessitate top prints for locating the barrel cores, a practice which is most undesirable.

The character and quality of the metal supplied for these cylinders is of vital importance. A close-grained cast iron which will enable the casting to withstand about 700 to 800 lbs. per sq. in.

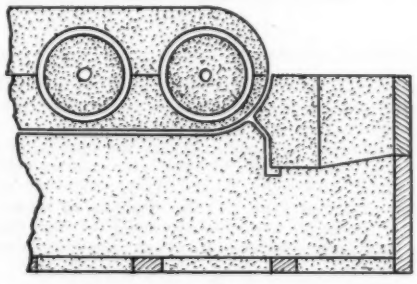


FIG. 21.—SECTION BELOW THE VALVE CHAMBER.

water pressure is desirable. To obtain a close-grained metal the silicon content must be low, but the quantity of silicon influences the character of the carbon content; when it is low more carbon is chemically combined and the metal is hard and brittle when formed into thin castings. The method of introducing steel scrap, in the form of punchings and cuttings from steel plates, into the cupola has met with considerable success in producing a metal of great strength and durability. It is known as "semi-steel" mixture. The introduction of steel scrap lowers the total carbon content, and if the metal poured into these moulds is low in carbon the castings would be hard. It is necessary, therefore, to increase the carbon content and to keep the silicon content low. Now it is known that manganese tends to

increase the capacity of iron to absorb carbon, but manganese also tends to keep the carbon in the combined condition, and this would be detrimental to the casting. If the silicon content is high it neutralises the effects of the manganese, as it converts combined carbon into graphitic carbon; hence, by having both manganese and silicon fairly high when steel scrap is used in the mixture, and working the cupola at

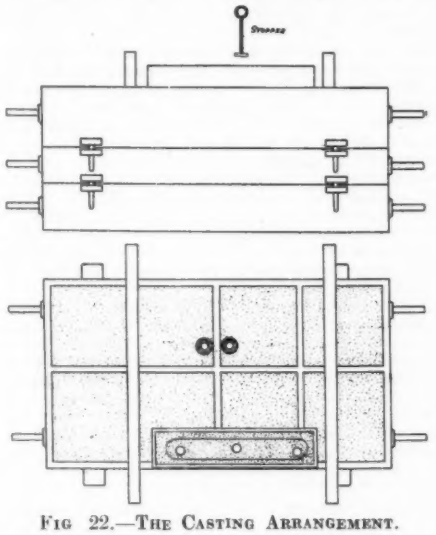


FIG 22.—THE CASTING ARRANGEMENT.

a fairly high temperature to make full use of the manganese, a metal will be produced which will be high in carbon and having suitable silicon content. This metal is very close grained and machines remarkably well. It should be poured hot and quickly. The form of runner already described with the aid of stoppers is particularly suitable for this so-called semi-steel, and with care in the management of the cupola, the percentage of wasters should be relatively small. The amount of steel scrap introduced into the mixture for thin work of this nature should not exceed 20 per cent.

Company News.

Head, Wrightson & Company, Limited. — Interim dividend, 5 per cent.; final dividend, 2½ per cent., less tax, making 7½ per cent. for year, less tax.

Brooks & Doxey (1920), Limited. — Final dividend, 4½d. per share, free of tax; bonus, 9d. per share, added to amount paid up on shares, making them 15s. 9d. paid up.

Allen Everitt & Sons, Limited. — Directors recommend final dividend at rate of 7½ per cent., tax free, on ordinary shares, making 7½ per cent. for year, carrying forward £4,537.

C. and L. Hill, Limited. — Capital £75,000 in £1 shares, to carry on the business of ironfounders. Registered office: Sandbeds Brass and Iron Foundries, Willenhall, near Wolverhampton.

Marine Castings & Supply Company, Limited. — Capital £1,000. Permanent directors: H. Puffett and P. H. Humphreys. Registered office: Leadenhall Chambers, 4, St. Mary Axe, E.C.3.

J. P. Evans & Company, Limited.—Capital £42,000, to carry on the business of ironfounders, etc. Directors: F. J. Cleeve, C. Cleeve, and T. Ryan. Registered office: 131, O'Connell Street, Limerick.

Mark Shaw & Sons, Limited.—Capital £30,000 in £1 shares (20,000 8 per cent. cumulative preference), to carry on the business of engineers. Registered office: Milnsbridge Iron Works, Pollard Street, Milnsbridge.

Charles Colman & Company, Limited.—Capital £2,000, to carry on the business of steel, iron and metal merchants, etc. C. Colman is permanent managing director. Registered office: 52, Peartree Street, Central Street, E.C.1.

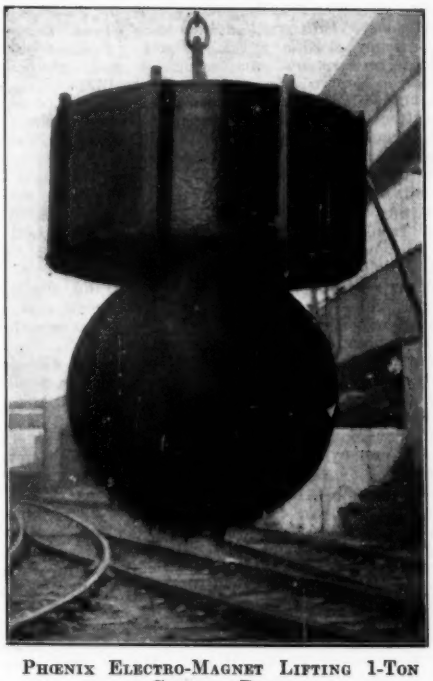
Horseley Bridge & Engineering Company, Limited.—Profits, £30,784; brought forward, £11,600; available for distribution, £42,384; dividend for year, 8 per cent., free of tax, £20,000; reserve fund, £10,000; carried forward, £12,384.

Newling Manufacturing Company, Limited.—Capital £1,000, to carry on the business of ironfounders, etc Permanent directors: H. J. Newton-Clare and E. M. Stirling. Registered office: 109, Jermyn Street, St. James's Street, S.W.1.

Scrap Breaking.

The convenience in operation and the saving of time and labour realised in the use of electro-lifting magnets for the handling of iron and steel products have already been explained in articles on the subject that have previously appeared in our columns. The illustration shows a magnet for the lifting and dropping of cracker balls for the breaking up of heavy scrap. Seeing that the attachment of the ball to the magnet for lifting and its release are entirely under the control of the crane or winch driver, by means of the magnet controller, it is obvious that the saving in time and labour which would be otherwise employed in connecting the ball to the lifting hook soon balances the initial cost of the magnet equipment.

The illustration shows a "Phœnix" electro magnet lifting a 1-ton cracker ball. The magnet



PHŒNIX ELECTRO-MAGNET LIFTING 1-TON CRACKER BALL.

is 30 in. in dia., is specially constructed for deep lifting, and weighs approximately 15 cwt. The ball will attach itself to the magnet when the latter is 4 in. from it. The attractive force of this magnet is further demonstrated by the fact that it lifts with ease two 4-ton ingots, which, of course, present a larger contact surface than the ball. In addition to lifting the cracker ball, the magnet can also be used for handling the scrap, with further economical results in the saving of time and labour.

As we have before noted, these electro magnets are sold by Messrs. E. G. Appleby & Company, Limited, of 70, Victoria Street, London, S.W.1.

Gazette.

BROUGHTON ENGINEERS, LIMITED.—It has been resolved and confirmed that the company be wound up voluntarily. Mr. C. M. Smart, Edinburgh, C.A., has been appointed liquidator.

MR. J. A. HARRISON, 579, Staniforth Road, and 4, Broad Street Chambers, Sheffield, iron and steel merchant, has been adjudicated bankrupt. Examination, County Court, Sheffield, July 21, at 2.30 p.m.

THE PARTNERSHIP heretofore subsisting between Messrs. G. W. Sheppard and J. W. Smith, metal merchants, 23 and 25, Moorgate Street, Leicester, under the style of Sheppard & Smith, has been dissolved.

MESSRS. ROBT. MACDONALD, DAVID BROWN SCRIMGEOUR and THOMSON SMITH AIKMAN, trading as the Central Engineering Company at 26, George Street, Glasgow, brassfounders, brass finishers and coppersmiths, have dissolved partnership. Mr. R. Macdonald continues the business.

Trade Talk.

FOR the first time since the war a nightshift has been commenced at Palmer's engine works, Jarrow.

THE TURBINE FURNACE COMPANY, LIMITED, have removed from 5, Budge Row, E.C., to 238b, Gray's Inn Road, W.C.1.

THE CAPITAL OF THE Somorrostro Iron Ore Company, Limited, is now £750 in 1s. shares, instead of £75,000 in £5 shares.

THERE was only one vessel launched into the Wear last month, this being built by Messrs. Sir James Laing & Sons, Limited.

THE capital invested in manufactures in Canada in 1867 was less than 78 million dollars, whereas in 1920 it was 3,034,301,915 dollars.

IT is reported officially from Johore that an iron mine has been opened in the district of Batu Pahat, and 5,000 tons of ore are being turned out a month.

W. JESSOP & SONS, LIMITED, of Sheffield, have officially denied the rumour that they had decided to close down altogether pending a revival in trade.

THE s.s. "PHILOTIS," at the King's Dock, Swansea, has discharged 20 large cases of rolling mill machinery, "made in Germany" and brought from Hamburg.

IN the Report stage of the Finance Bill two clauses relating to E.P.D. are to be moved as a result of representations made by the Federation of British Industries.

A DECREE HAS BEEN ISSUED in Buenos Aires declaring that the concession granted to Vickers, Limited, for the construction of a shipyard at La Plata has lapsed.

A REPORT from New York states that the U.S. Cast Iron Pipe & Foundry Company has made a 15 per cent. reduction in wages of its employees at Addison, Ohio.

WITH a view to encouraging export trade, the Glasgow Chamber of Commerce, by arrangement with the Department of Overseas Trade, have opened an exhibition of foreign manufactured goods.

MESSRS. BUTTERS BROS. & COMPANY, of Glasgow, have secured an order for six large steam travelling cranes. The money involved is over £25,000, and the order is for a foreign Government in the East.

A NEW YORK CABLE ADVICE states: The Bethlehem Steel Company announce a reduction in current prices of steel of $4 (16s.) a ton. It is also announced that tin is reduced by $10 (£2), and galvanised sheets by $5 (£1).

ACCORDING to Mr. T. W. How, chairman of the Engineering Section of the London Chamber of Commerce, there is a general impression that the adjustment of labour difficulties will be followed by a revival in the engineering trade.

ONE of the most extensive fire outbreaks in Cardiff for some time past has occurred at the Crown Wagon and Engineering Works, Maindy (Messrs. Hall, Lewis & Company), resulting in damage to the extent of several thousands of pounds.

THE IRON ORE of the Mertainen orefields, near Kiruna, in Lapland, has now been thoroughly examined, the percentage of iron being 65.5 to 68.5, and of phosphorus 0.006 to 0.008. The quantity of ore of these orefields is estimated at 35 to 40 million tons.

THE ANNUAL DINNER of the London Chamber of Commerce, at which H.R.H. the Prince of Wales, K.G., has accepted an invitation to be the principal guest, and which was postponed on account of the industrial situation, will take place on Tuesday, the 26th inst., at the Connaught Rooms.

IN reply to Mr. Haslam, Dr. Macnamara said:—On June 24, the latest date for which figures are available, the number of persons on the live registers of employment exchanges as unemployed was 2,177,899, while about 832,000 persons were claiming benefit in respect of short-time working.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, announce that their Civil Engineering and Contracting Department has removed to new offices at 51, Victoria Street, Westminster, S.W.1. The Hydro-Electric Section will remain at 3, Great George Street, Westminster, S.W.1.

MESSRS. VICKERS, LIMITED, have taken over the Canadian manufacturing and selling rights of the well-known Ajax pneumatic moulding machines, handled in this country by the patentees, Messrs. John Macdonald & Son, Limited, of Glasgow.

AT A CONFERENCE held at York last week between certain representatives of employers in the iron and steel trades with the National Union of General Workers and the National Amalgamated Union of Labour, agreements were signed relating to wages and conditions.

THE railway statistics for the month of April reveal the first effects of the coal stoppage on freight traffic. The total tonnage conveyed in April, 1921, showed a decline of 18,265,838 tons, or 67 per cent., compared with April, 1920, and the ton-miles worked 597,123,919, a decrease of 62 per cent.

IT HAS BEEN DECIDED, on the request of of the Labour Co-partnership Association, to organise at the Crystal Palace an exhibition of manufactures produced under co-partnership and profit-sharing conditions or welfare developments. The exhibition will be open from September 1 to October 22.

A PRELIMINARY statement of the 1920 census of shipbuilding prepared by the United States Bureau of the Census Department of Commerce shows that there were 1,076 establishments engaged in shipbuilding in 1919, which performed work during the year to the value of $1,622,361,000, as compared with 1,137 establishments in 1916.

AS A RESULT of the ascertainment of the average net selling price of steel plates at Consett for the three months ended May 31, the wages to be paid to the steel mill men during July, August and September will be 155 per cent. above the standard, or, in other words, 35 per cent. below the wages prevailing during the previous three months.

WITH regard to the position of the Consett Iron Company, Limited, it is authoritatively stated that it will not be possible to re-start the various departments for some time at the Consett works, even when the miners commence work. In the first place, the company have no orders on hand, and in the second place, there is a great shortage of water.

AT the recent annual inspection of the National Physical Laboratory by the General Board, there was an interesting ceremony, Sir Joseph Thomson presenting, and Professor Cherrington receiving, on behalf of the Laboratory, a bronze bas-relief of Sir Richard Glazebrook, who was the Director of the Laboratory from its foundation until 1919.

THE President of the Society of British Gas Industries has on several occasions urged the importance of closer working between the retort setters and the manufacturers of fireclay goods; and it has been suggested that Sections I. and X. should be joined up. The two sections have now decided to hold joint meetings, and it is felt that much good will come from discussions of the needs of the one section and the difficulties of the other.

BRUCE PEEBLES & COMPANY, LIMITED, have recently appointed Charlesworth Peebles & Company, of 134, St. Vincent Street, Glasgow, as their agents for the whole of Scotland, with the exception of the area in the East of Scotland, which for many years has been covered by Mitchell, Graham & Son, Limited, 56, Buccleuch Street, Edinburgh. Mr. J. A. Hood still remains the Scottish representative of Bruce Peebles & Company, Limited.

SLIDING SCALE ARRANGEMENTS have been set up for the steel tube industry. It will be dependent on the prices of certain products of the industry and bonuses will also be regulated similarly. The bonus is to be taken according to the percentage, value, and price of the commodity in the trade, and then worked on a sliding scale principle. So far reports received from the districts show that the men concerned are agreeable to the adoption of the arrangement.

THE BOARD OF TRADE announce that by an agreement made with the German Clearing Office, now awaiting the approval of the Reichstag, the time for lodging claims with the British and German Clearing Offices, by their respective nationals under Article 296, Section III., Part X., of the Treaty of Versailles has been extended to September 30, 1921. No further claims under the above Article will be accepted after that date by the Clearing Offices concerned.

THE ANNUAL EXHIBITION known as the London Fair and Market was opened last week at the Royal Agricultural Hall by Sir William Joynson-Hicks, M.P. It is solely for the transaction of wholesale trade business, and is not open to the public. The exhibition is international in character, and while eighty per cent. of the exhibits are of British manufacture, there are industries of France, the United States, Japan, Italy, Holland, Belgium, Switzerland and other countries represented.

LICENCES UNDER THE Non-Ferrous Metal Industry Act, 1918, have been granted to:—Boulton & Company, H. H. 26a, Cannel Street, Ancoats, Manchester; George Casting and Metal Company, Limited, 38 and 39, Moland Street, Birmingham; Howells, D. E., 19, Station Road, Port Talbot; McBain, Neville Sievwright, trading as McBain & Company 126, Bishopsgate, London, E.C.2; Parker & Company, Limited, A. and F., 96-8, Leadenhall Street, London, E.C.2; Willmott, Son & Phillips, A. V., St. John's House, 124, Minories, London, E.1.

SCHOLARSHIPS for apprentices and students in shipbuilding and marine engineering, ranging in value from £100 to £150 per annum, are offered annually by various firms or by endowment, and are administered by the Council of the Institution of Naval Architects. Two such scholarships in naval architecture, and two in marine engineering, are now offered for competition, the entries closing on July 31. Full particulars and forms of application may be obtained from Mr. R. W. Dana, Secretary, Institution of Naval Architects, 5, Adelphi Terrace, W.C.2.

XUM

IRON AND STEEL MARKETS.

Pig-iron.

The restoration of active production in the coalfields has, so far, had little stimulating effect upon the pig-iron industry, and with a few exceptions furnaces remain idle, corresponding with a generally cautious attitude upon the part of buyers. There is, in fact, little encouragement to consumers to come into the market, foundrymen, especially, finding it increasingly difficult to obtain supplies of their particular qualities of iron, while, on the other hand, smelters are still left in doubt as to possible future prices they will have to pay for fuel. In these conditions it is obviously impossible to negotiate business on a practical basis, and until the precise figures at which coal can be bought are ascertained no general resumption of activity can be anticipated. Reports from colliery areas are, however, reassuring with regard to full supplies of fuel being shortly forthcoming, and when this becomes an accomplished fact there will doubtless be some revision of prices in a direction favourable to iron producers' interests. In the Cleveland area it is now definitely understood that ironmasters do not at present contemplate producing pig-iron for the open market, the output of the few blast furnaces which are now in operation going to the local steel works. Thus, it would appear probable that more pig-iron must be imported into this country from abroad, for stocks of foundry iron are now approaching exhaustion, and production has ceased. On the other hand, where forge and other low-grade iron can be used it will be used. As has been the case for some time, forge iron is being offered at 117s. 6d. per ton, as against 135s. for foundry iron; but for many purposes forge iron is unsuitable, and consumers prefer to pay the higher figure for the foundry quality. It is not improbable that a rise in the official minimum in Cleveland iron will take place at an early date. At present it still stands at 125s. for No. 1, 120s. for No. 3, and 119s. for No. 4, but as a matter of fact, No. 1 is unobtainable, and 135s. has to be paid for No. 3 and No. 4 foundry iron for July deliveries, whilst for August 140s. is quoted. In the Midlands supplies of pig-iron are very short, but the interruption of output has enabled stocks to be cleared, and up to the present current production is far below normal. If there were any pressure of demand one might expect to see all the furnaces being put promptly into blast, and quotations stiffening, but the price at which Continental iron can be imported holds everything in check. Even where it is unsuitable for use it influences consumers' ideas and makes trade very difficult.

In the West of Scotland both pig-iron makers and consumers are waiting developments and there is very little business passing. It would appear as if the termination of the strike had been discounted, as there is less actual business doing now than there was a few weeks ago, consumers having taken in sufficient iron to give them a start when the position warrants their resuming. Prices for the small quantity of foundry iron remaining in stock continue strong, as the prospect of replacing stocks is so uncertain.

There has been a little more inquiry for East Coast hematite, but only limited business has resulted, and makers are still prepared to accept 140s. for mixed numbers for export. That may not last much longer, as makers' price is still 160s. per ton, and the home demand is likely to improve. There is no definite information as to when there there will be renewed activity in the hematite pig-iron trade in North Lancashire and South Cumberland. The district had practically ceased to produce iron before the miners stopped work in March last at which time only a single furnace at Ulverston was in operation in the whole district. Inquiries show there is considerable uncertainty, and even with a cheaper supply of fuel it would be well into next month before iron is again produced.

The half-year just closed will unquestionably rank as the most disastrous in the history of the iron and steel trade of the Cleveland district. The average monthly output of pig-iron on the North-East Coast last year was 218,900 tons; in April of this year it fell to 21,300 tons, in May to 11,900 tons, and the figures for June will certainly show a further decline, for early in June production ceased entirely.

Ore.

Business in this class of raw material is, and has been for a long time past, practically a dead letter, smelters' yards everywhere being largely over-stocked, and until furnace operations are resumed, a highly problematical date to fix, buying in the Tees-side market is completely suspended. There have been no cargoes reported landed at Middlesbrough ports so far during the present month, the total ore imports to June 9, amounting to 10,642 tons only.

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Steel.

Although considerably modified by the return of miners to the collieries, the outlook in the home trade continues full of uncertainty owing, of course, to the difficulty of estimating costs of production in the near future. Some of the works in the Sheffield district are reported to have already re-started, but the movement so far has been by no means general, and there is still a large number of steel-workers unemployed in the neighbourhood. It is further expected that any revival of activity, due to a resumption of regular fuel supplies, can only be of a partial character, and in cases where there has been an accumulation of orders during the strike period. Several acid steel furnaces are, it is stated, to be re-started as soon as fuel supplies are assured, but the numerous basic furnaces are still without work, or much prospect of anything doing until the autumn. Steel forges and rolling mills report a fair volume of specifications in hand, while the outlook for the steel foundries is also regarded as more favourable than of late. An encouraging feature of the present position in the Sheffield steel trade is a heavy volume of inquiries from most parts of the world for local products, which has, it is said, largely increased since the termination of the miners' trouble, and if translated into actual business will largely benefit the local industries. At all events these inquiries evidence the world-wide demand for Sheffield products and if prices can only be brought within range of the buying power of foreign markets should provide ample work for the thousands of unemployed now subsisting on the State system of doles. Prices, meantime, remain practically stationary, any revision contemplated being held over until future coal values are ascertained.

Finished Iron.

The position in the manufactured iron departments remains much the same as when last reported, but with fuel supplies coming forward more freely some activity has been developed at the marked bar mills. Makers of this material are now able to push forward any orders they have in hand, and contracts delayed by the stoppage of the mills are in course of delivery. There is also some inquiry for merchant bars, of which certain sizes are out of stock, and replenishment of warehouse reserves is considered desirable. There is only a poor demand for nut and bolt iron, and, in fact, buying all round, except in small lots for prompt requirements, is on quite a limited scale. There has been no change to note in current quotations, which remain steady at previous figures.

Scrap.

With the lightening of the labour troubles as a disturbing factor in the position of the iron and steel trades, hopes are justifiably entertained of an early revival in the markets for this material, due in a measure to the certainty of a more or less prolonged scarcity of foundry pig, and the comparative cheapness of scrap as a substitute for casting work. This conclusion is reflected in the Lancashire area, where inquiry for cast scrap iron is apparently improving. Dealers are trying to maintain the Lancashire prices at £6 to £6 10s. for ordinary machinery scrap, and £7 to £7 5s. for textile, on the plea that pig-iron costs a good deal more, but it is indisputable that the foundry trade of Lancashire cannot prosper until pig-iron in the district is much cheaper, and hence cast scrap will have to be cheaper, too. The demand for heavy wrought scrap and for steel scrap is at present in abeyance, though the Lancashire bar-iron makers are said to be still taking it in when offered at £3 per ton. The steel works are, of course, not yet open for any heavy steel scrap, and do not care to take it in even at £3 per ton. At Middlesbrough business in scrap is quite stagnant, except for a few purchases for stock here and there by the works where parcels could be picked up at a moderate figure. Works are offering about £3, delivered, for steel scrap, but there are very few sellers at this extremely low figure. Small lots of heavy cast iron have been sold at £5 10s. to £5 15s. per ton. Prices otherwise are completely nominal.

Tinplates.

Conditions in the tinplate trade continue quiet, and are expected to remain without much change until work can be fully resumed at mills, an event, it is hoped, that may shortly result, with fuel supplies more readily available. Even then it is regarded as doubtful, whether the position will improve while costs of production leave makers but little margin of profit. The demand is mainly confined to stock plates, which are changing hands at round 27s. to 27s. 6d. basis for coke finish, net cash, f.o.t. at works. There is but little inquiry for forward shipment; 25s. to 26s. is being quoted for September to December. Wasters are in quiet demand, and are realising 40s. for C.W. 28 by 20, 16s. 6d. for CW. 14 by 18¾, and 23s. for CW. 20 by 10. Light weights are scarce, and command as much as, or more, than full weights. Ternes are nominally 26s. 6d. basis, with business very slow.

Metals.

Copper.—The week's markets for standard copper opened with a firm tone and a rather better demand by consumptive interests, a further decline in the American exchange being a distinctly favourable point, July metal was sold at £72 17s. 6d., September £72 10s., October £72 12s. 6d., while electrolytic and wire bars closed 20s. better, or unchanged at £76 10s. to £77 10s. Closing prices:—Cash: Wednesday, £72; Thursday, £72 2s. 6d.; Friday, £72 7s. 6d.; Monday, £72 10s.; Tuesday, £72. Three Months: Wednesday, £70 2s. 6d.; Thursday, £72 2s. 6d.; Friday, £72 7s. 6d.; Monday, £72 10s.; Tuesday, £72 2s. 6d.

Tin.—The more favourable conditions with regard to labour and political troubles have failed, to some extent, in stimulating activity in the market for tin, business at this week's opening being quiet and inclined to an easier tendency in values, cash Straits selling at 10s. over standard. So far, consumptive demand has not developed from South Wales tinplate trade to the extent anticipated, and further weakness was experienced towards the close, which was barely steady with a loss on balance both for prompt and forward tin. July was done at £167 to £166 10s., August £167, and September at from £169 to £168. English ingots were nominal at £165. Closing prices:—Cash: Wednesday, £169 10s.; Thursday, £168 10s.; Friday, £168 7s. 6d.; Monday, £166; Tuesday, £166 5s. Three Months: Wednesday, £171 10s.; Thursday, £170 10s.; Friday, £170 7s. 6d.; Monday, £168 10s.; Tuesday, £168 5s.

Spelter.—The market for this metal opened steady, and with a prospective early improvement in demand by galvanisers prices continue firm. There were July sellers at £27, with buyers at £26 15s., August buyers at £26 17s. 6d., and September sellers at £27 7s. 6d. October was sold at £27 7s. 6d., English was quoted nominally at £33 10s. Closing prices:—Wednesday, £27 2s. 6d.; Thursday, £27 2s. 6d.; Friday, £27 2s. 6d.; Monday, £27 2s. 6d.; Tuesday, £27 2s. 6d.

Lead.—Offerings during the early week were on a heavier scale, but values remained unchanged, July was quoted £23 to £23 2s. 6d., and August and October at £23 2s. 6d., with English unchanged at £24 10s. English closing prices: — Wednesday, £24 10s.; Thursday, £24 10s.; Friday, £24 10s.; Monday, £24 10s.; Tuesday, £24 10s.

MISCELLANEOUS advts., see also page 16.

FOR SALE, cheap, 100 tons of Foundry Pig-iron, planished, and C.R. C.A. Sheets, Joists, Channels, Angles, Tees, Plates, all thicknesses, Plumbago.—Ascog, 10, Goldsmith Place, Kilburn, N.W.6. Telephone: Hampstead 8532.

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